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## LIGATURE OF THE INNOMINATE ARTERY FOR CURE OF SUBCLAVIAN ANEURISMS

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THE case which forms the basis of this communication was one of spontaneous aneurism of the axillary artery involving also the third and second parts of the subclavian. The sac was an enormous one, and reached from the scalene muscles above to the axillary outlet below. The axillary portion was many times larger than the subclavian.

Ligature of the innominate artery as a method of curing subclavian aneurisms must always be looked upon as a last resort. It must only be attempted if other methods are unsuitable in the particular case under treatment.

Savariaud<sup>1</sup> divides subclavian aneurisms into two classes, (1) extrascalene and (2) intrascalene, according to the position of the sac. Those belonging to the extrascalene variety can usually be treated without interfering with the innominate trunk, while those belonging to the intrascalene variety will often necessitate ligature of this vessel.

These aneurisms have been treated by the following methods (Savariaud):

I. Direct attack.

(a) Open operation (Antyllus; Matas).

(b) Extirpation.

II. Indirect attack (ligature).

(a) Proximal ligature (of the third, second or first part of subclavian, or of the innominate).

(b) Distal ligature (of third part of subclavian or axillary).

I. DIRECT ATTACK.—If the proximal circulation can be controlled

<sup>1</sup> Savariaud: Anévrysmes de la sous-clavière. *Revue de chirurgie*, 1906, t. xxxiv, p. 1.

by a clamp or temporary ligature placed on the subclavian the best method of treating these cases is by *direct attack*, *i.e.*, by opening the aneurism (Antyllus), cleaning out the clots, and securing the vessels opening into the sac. This part of the operation can be finished according to Matas' advice, either by an obliterative or possibly reconstructive aneurismorrhaphy. If effective hæmostasis can be obtained, the operation is very successful. Matas<sup>2</sup> reports 7 obliterative operations with only one death, *i.e.*, 95.4 per cent. of successes. Savariaud speaks very highly of *extirpation* of the aneurismal sac. He collected 7 cases with one death. It is hardly likely, however, that this operation will survive. Compared with the Matas procedure it is more difficult, and however carefully the dissection is conducted, the collateral channels will be in danger of division.

II. INDIRECT ATTACK.—(a) *Proximal Ligature*.—*Ligature of the subclavian artery*: Ligature of the *third part* of the subclavian artery. This is a highly successful operation. It has usually been employed in the cure of axillary aneurisms or in subclavio-axillary aneurisms in which a sufficient length of the third part of the subclavian artery outside the anterior scalene muscle was free from the aneurismal sac.

The artery is peculiarly suited for the operation. It is easily accessible and is usually free from branches. If a branch happens to arise from this part it is usually the posterior scapular. In extrascapular aneurisms the objective point should always be the third part of the subclavian. If inaccessible the ligature must be placed further up stream. Savariaud collected 9 cases with only 1 death, which occurred from embolism on the twenty-second day.

*Ligature of the second portion of the subclavian artery*: In some cases of extrascapular aneurism it may be found that no part of the third portion of the subclavian artery is suitable for a ligature. If the anterior scalene muscle is divided and the phrenic nerve retracted, the second portion of the artery can be exposed and tied. As would be expected, this operation is as successful as ligature of the third part, because the ligature is invariably placed below the superior intercostal artery, *i.e.*, below the branches which may be required as collateral channels. Savariaud collected four cases, all successful.

*Ligature of the first part of the subclavian artery*: Ligature of this arterial trunk has turned out to be a very unsatisfactory operation. It is both difficult and dangerous. The artery is very short, numerous branches arise from it, it is very deeply situated and is surrounded by

<sup>2</sup> Matas: Trans. Internat. Congress of Medicine, 1913, Lond., Eng. Surgical section. Discussion on the surgery of the arterial system.



## LIGATURE OF THE INNOMINATE ARTERY

important veins and nerves. The internal jugular and vertebral veins are directly in front of it; also the pneumogastric and phrenic nerves. At its origin, the right innominate vein forms an anterior relationship.

In cases of aneurism the venous trunks are usually greatly distended and block the approach to the artery. The numerous arterial branches hinder the passage of the aneurism needle. After a ligature has been successfully tied, the obliteration of the vessel is problematical, because clotting is impossible except in the immediate neighborhood of the ligature. If by any chance the wound becomes infected, secondary hemorrhage is very liable to occur at the site of ligature. If on the other hand massive clotting and extensive obliteration of the main arterial trunk occurs, the branches arising from it will become obliterated with serious embarrassment of the collateral circulation.

Secondary hemorrhage (twice in nine cases) and return of pulsation (three times in nine cases) have been too frequently observed to permit the operation to occupy a high place in our esteem (Savariaud). If ligature of the first part of the subclavian is contemplated, the site of ligature should always be distal to the origin of the thyroid axis so as to leave the suprascapular artery free to carry blood to the arm. If the ligature is placed proximal to the origin of the vertebral, it would hardly be wise to tie this trunk at the same time, especially if the collateral circulation was already embarrassed by the centrifugal pressure of the walls of the aneurismal sac. Blood flowing refluxly down the vertebral would probably be needed to supply the collateral circulation when the aneurism underwent consolidation. The same reflux stream would hardly be powerful enough to prevent consolidation. Ligature distal to the thyroid axis and vertebral would be more likely to be followed by consolidation of the aneurism.

*Ligature of the innominate artery:* In the treatment of intrascapular aneurisms, ligature of the innominate with or without simultaneous ligature of the carotid is usually the only procedure open to us.

Since the year 1880, the innominate has been tied 26 times for the cure of aneurism of the subclavian artery, with 12 recoveries and 14 deaths.

Table of cases of aneurism of the subclavian artery operated upon by ligature of the innominate artery since the year 1880 follows:

	Cases	Recoveries	Deaths
Spontaneous aneurisms .....	23	10	13
Traumatic aneurisms .....	3	2	1
	—	—	—
Total .....	26	12	14

JAMES E. THOMPSON

	Cases	Recoveries	Deaths
Ligature of the innominate artery alone.....	12	5	7
Ligature of the innominate and carotid simultaneously .....	12	7	5
Ligature of the innominate, carotid, and vertebral simultaneously .....	2	0	2
Total .....	26	12	14

The death roll (14 deaths in 26 cases, *i.e.*, 53.8 per cent.) is enormous, but the disease is almost certainly fatal sooner or later unless treated by surgical means.

The operation is one of last resort and should only be attempted if ligature of the subclavian artery in some part of its course is impossible.

In intrascapular aneurisms no other course is open. The first part of the subclavian is occupied by the aneurism and inaccessible to ligature. In extrascapular aneurisms it would probably be wiser to attempt to place a ligature on the first part of the subclavian, and failing in this to tie the innominate and carotid.

(b) *Distal Ligature.*—In the treatment of subclavian aneurisms, distal ligature ought to be given proper consideration, particularly in cases where proximal ligature is impossible or inadvisable. Intrascapular aneurisms are often associated with and part of an aneurismal dilatation of the innominate. Ligature of the third part of the subclavian and simultaneous ligature of the carotid is the recognized treatment of these conditions and is highly successful. In extrascapular aneurisms, proximal ligature is the procedure of choice. If, however, this is not feasible ligature of the first or second part of the axillary has been successful in curing some of these cases (Barkley,<sup>3</sup> Braun<sup>4</sup>). Monod<sup>5</sup> tied the termination of the third part of the subclavian and the common carotid and cured an aneurism of the third part of the subclavian. Gérard-Marchant<sup>6</sup> successfully tied the carotid and the axillary for the cure of an aneurism occupying the whole subclavian artery. In cases of aneurisms of large extent prohibiting proximal ligature, it would seem wise to try the effects of distal ligature and in the event of failure to use other means. A case reported by Thorburn<sup>7</sup> is one in point. An extensive traumatic aneurism occupying the whole left subclavian artery was treated by distal ligature of the axillary artery between the second and third portions. Pulsation returned in the sac

<sup>3</sup> Barkley: New York Med. Journ., 1900.

<sup>4</sup> Braun: Deutsche Zeitschr. f. Chirurgie, 1903, t. lxi.

<sup>5</sup> Monod: Bull. de l'Acad. de Méd. de Paris, 1895, p. 97.

<sup>6</sup> Gérard-Marchant: Bull. de l'Acad. de Méd., Aout, 1901.

<sup>7</sup> Thorburn: Brit. Med. Journ., 1895, vol. i, p. 909.

## LIGATURE OF THE INNOMINATE ARTERY

on the seventeenth day. Electrolysis was employed and a cure resulted.

The site of ligature is important. It should be as near to the aneurismal sac as possible. Under no circumstances must the ligature be placed distal to the origin of the posterior circumflex and subscapular vessels. The site of ligature must be above these vessels. If placed below, the circulation of the arm will be imperilled; and, further, the aneurismal sac will be in full connection with the collateral circulation from its distal side.

### ILLUSTRATIVE CASE

A. J., aged forty-six; male; colored. The patient was a powerful negro who was admitted to the John Sealy Hospital on June 22, 1914, suffering from a large pulsating swelling occupying the right axillary and supraclavicular spaces.

*Previous History.*—The patient was a dock laborer and had daily been accustomed to most strenuous work until about seven years ago. There was a positive history of gonorrhœal infection. There was no history of syphilitic infection. He had not been addicted to excesses in alcohol.

*Present Trouble.*—The history of the onset of the axillary swelling was very vague. Painful kernels (lymphatic nodes?) had appeared and disappeared in various parts of his body. Six weeks ago a swelling (kernel) appeared in his right arm-pit. Gradually the tissues in front of the right shoulder were involved. Four days before admission, the arm began to swell, and he suffered from intense pain in the back of the hand and wrist. Before this period he had no knowledge of the existence of a swelling either above or below the collar bone.

On admission, the condition of the patient was as follows: He was a magnificent specimen of manhood, although somewhat emaciated and careworn. His facial expression was eloquent of suffering (see Fig. 1). Occupying the whole axillary space of the right side was a huge swelling which extended upward above the clavicle into the supraclavicular space. The right arm and forearm were greatly increased in size and the skin was stretched and tense and very œdematous. Large veins could be seen in the subcutaneous tissue of the arm and forearm. The arm and forearm were swollen and œdematous. He complained of almost constant pain of a boring, burning character in the hand and wrist, which was alleviated by raising the shoulder.

The axillary and supraclavicular swellings were continuous. On inspection the outline of the clavicle was obliterated, but it could be palpated clearly. Over the surface of the tumor pulsation of a typically expansile character was visible and palpable.

It extended as low as the axillary outlet. The axillary floor was depressed and bulged. The skin covering it was œdematous and thrown into creases. The radial pulse was imperceptible. The circulation in the arm was evidently much embarrassed.

Examination of the heart revealed nothing abnormal. There was no undue pulsation in the supraclavicular space. The sternal and clavicular origins of the right sternomastoid were quite prominent, but they did not stand out in relief quite so distinctly as those on the left side. Blood examination showed a leucocytosis of 28,500 and 87.3 per cent. of polynuclear cells. Unfortunately, the red count and percentage of hæmoglobin are not recorded. The Wassermann reaction was positive. The urine showed nothing abnormal.

On June 23, under novocaine infiltration anæsthesia, the innominate artery was ligatured. A transverse incision about two fingers' breadths above the clavicle was carried, from the middle of the right supraclavicular space, inward across the insertion of the sternomastoid muscle to the middle line of the neck. Successive division of the sternomastoid, sternohyoid and sternothyroid gave a clear exposure of the lower portion of the carotid packet of vessels. The scalenus anticus and phrenic nerve were recognized. Following the scalenus anticus downward to the first rib, it was found to fuse with the supraclavicular swelling. Further dissection revealed the fact that the second and third parts of the subclavian artery were involved in the aneurismal sac and that the insertion of the scalenus anticus blended with the inner wall of the sac. Ligature of either the third or second parts of the subclavian artery was out of the question. Search was now made for the lower portion of the common carotid with the intention of following it down to the bifurcation of the innominate. During the search a somewhat tortuous artery was encountered just above the sternal notch. This was followed downward as a single trunk behind the sternum. Fully  $\frac{1}{2}$  inch above the sternum, it bifurcated. One branch passed upward and was identified as the right common carotid. The other, evidently the first part of the subclavian, passed downward and backward and entered the lower and inner side of the aneurismal sac. The carotid trunk seemed unusually small. The subclavian was much larger. It was very short and firmly fixed, and so deeply situated that it seemed unwise to try to identify any of its branches.

The main arterial trunk, which was without doubt the innominate, was carefully cleaned and ligatured. Owing to its accessible position this was an easy task. Before the ligature was tied, the vessel was compressed and pulsation ceased in the aneurism. The ligature material used was the narrow linen tape employed



FIG. 1.—Right subclavio-axillary aneurism.



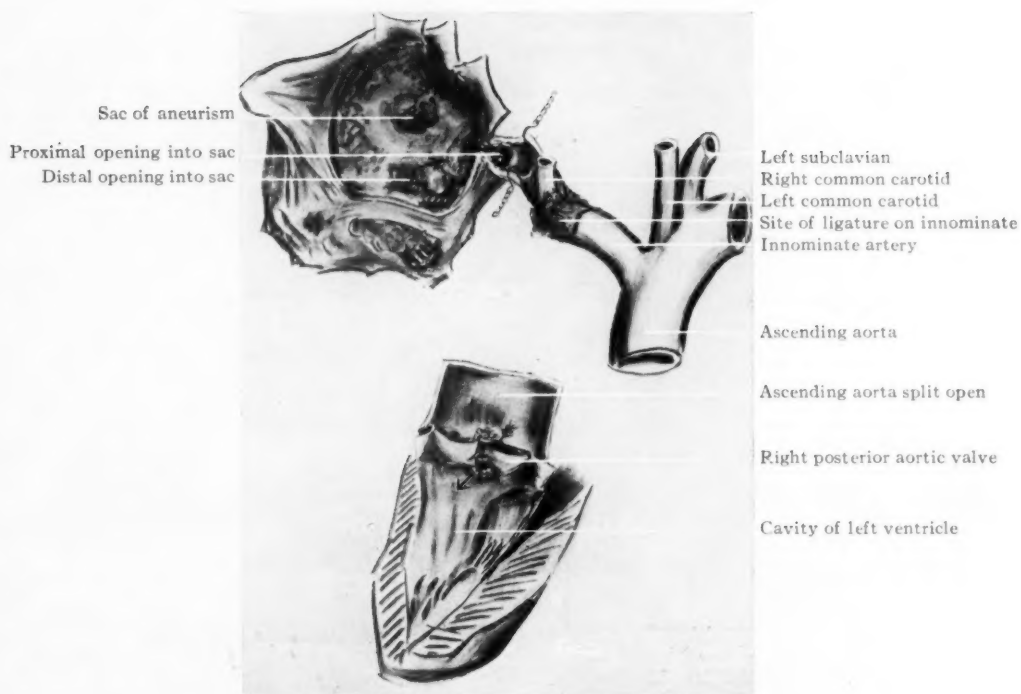


FIG. 2.—Shows the left ventricle of the heart laid open and two of the valves of the heart exposed, viz., the anterior and the right posterior. A perforation (shown by the arrow) is seen in the right posterior valve. Part of the commencement of the aorta shows several patches of atheroma.

FIG. 3.—Shows the remainder of the aortic arch and its branches. Near the bifurcation of the innominate artery the site of ligature is shown. The branches of the first part of the subclavian were unfortunately not dissected out. The sac of the aneurism has been emptied of clot to show the position of the distal opening of the axillary artery.

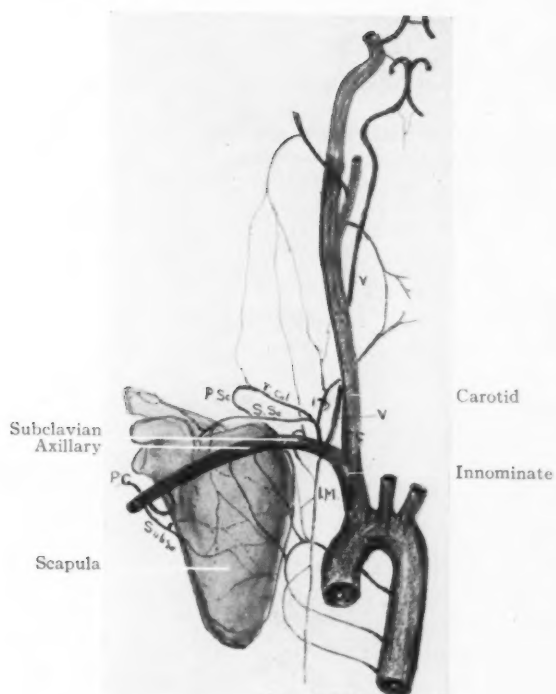


FIG. 4.—Diagram showing arterial anastomosis around the scapula. CC, common carotid (right); V, vertebral; I.M., internal mammary; I.Th., inferior thyroid; T.Col., transversalis colli; P.Sc., posterior scapula; S.Sc., suprascapular; Sub.Sc., subscapular; P.C., posterior circumflex.



## LIGATURE OF THE INNOMINATE ARTERY

in obstetrical practice for tying the umbilical cord. (This tape goes by the name of "bobbin" and is about 1/10 inch wide.) Two of these ligatures were tied side by side and the knot finished as the stay knot (Ballance and Edmunds). The common carotid was not tied. After the ligature was tied, not the slightest pulsation was visible in the aneurism.

No cerebral symptoms followed the operation. The arm became completely paralyzed and anæsthetic almost immediately. No pulsation was visible in the aneurismal sac. The arm still remained œdematous. The axillary swelling did not decrease in size. He still complained of considerable pain in the hand and forearm.

Except for complete paralysis of the upper extremity his general condition remained fair, until the middle of July, when he began to complain of pain once more in the site of the old aneurism. On July 18, a soft fluctuant tumor was discovered, in the floor of the right axillary space. There was still no sign of pulsation in the old aneurismal sac. On July 21, aspiration revealed the presence of pus. The next day, July 22, a large axillary abscess containing about a pint of blood-stained pus was opened and drained. The cavity continued to drain and the patient improved and gained strength. On August 1, during the night, a very profuse hemorrhage occurred from the walls of the abscess cavity. This was stopped by careful packing of the cavity. No further bleeding occurred after the packing was removed and the patient continued to progress favorably, with the exception of two small carbuncles which appeared on his back. Almost a month later, without any warning, the patient suddenly became unconscious. This occurred at noon, on August 29. Cheyne-Stokes respiration made its appearance and he died at 4 P.M. on the same day (sixty-seven days after the operation).

The *autopsy* was a very complete one. Careful search was made for embolism of one of the cerebral arteries, but none was found. Except for marked cerebral anæmia, nothing abnormal was found in the brain.

*The Heart.*—The greater part of the cusp of the right posterior and the contiguous part of the anterior semilunar valves were deeply ulcerated (Fig. 2). A large perforation was found in the right posterior valve. The eroded portions of both valves were adherent to the wall of the aorta just above the sinuses of Valsalva. No thrombus was found in either coronary artery and both lumina were patent. The first part of the aorta showed several patches of atheroma.

The innominate artery was capacious and fairly healthy. It was 5½ cm. long. The inner coat showed no traces of atheroma. From the left side, just at its commencement, the left carotid trunk took its origin. About 2 cm. below its bifurcation was the site of ligature. Externally, this was covered

by a dense mass of scar tissue. Internally, the lumen was not completely obliterated, but admitted easily the end of a fair-sized probe. After slitting the artery up, the site of the ligature was shown by a transverse ridge, the edges of which were ragged and friable (Fig. 3). In places the intima was lost, and minute ragged holes were seen which led into the substance of the arterial wall. Portions of the linen ligature could be seen through these apertures. There was no clot on the ragged edges of these small holes. They had the appearance of having been produced mechanically (postmortem) by pulling open forcibly the sides of the artery after it had been slit open.

The arteries were carefully examined on the distal side of the ligature. The carotid was quite normal. The subclavian was a little dilated. At a distance of 2 cm. it passed into the consolidated mass which represented the sac of the aneurism. On slitting it up, the inner coat was found to be smooth and apparently healthy. After tunnelling the wall of the sac for 2 cm. the vessel opened into the cavity of the aneurism. The margins of this opening were abrupt, irregular and crenated. The interior of the aneurismal sac was filled with consolidated clot. This was dark-colored near the opening of the artery, but white and fibrinous elsewhere. After peeling away a quantity of clot from the interior of the sac, the inner lining of the wall was examined. It was rough everywhere, and no traces of endothelial lining could be discovered. The clot was so adherent to the wall of the sac in every part and so little of it was red that there was no reason to believe that blood had been circulating through the aneurismal sac since the ligature had been placed on the innominate.

The distal opening of the axillary vessel was found after the clot had been peeled from the sac. This was situated 7 cm. from the proximal opening. It was absolutely obliterated, being filled with organized clot. Three centimetres distal from the sac the axillary artery was patent. The wall of the sac was very thick and was formed by adventitious tissue, in which were incorporated pectoral muscles, axillary nerves, and at its inner aspect scalenus medius and scalenus anticus. The whole sac measured 17 cm. in length and 14 cm. in breadth. Its lower aspect was hollowed out by an irregular cavity consisting of numerous intercommunicating pockets which contained pus (axillary abscess). It was otherwise filled completely with clot, which was everywhere so adherent to the wall that it could only be peeled off by using great force. The aneurism was completely consolidated.

The line of treatment was finally decided upon during the development of the operation, as it was not possible to tell until the anterior scalenus muscle had been exposed whether the third or perhaps the second part of the subclavian artery could be tied or whether a ligature would have to be placed further up stream nearer the heart.

We had hoped to have been able to have controlled the circulation on the proximal side by clamping the second or third part of the subclavian, and to have completed the operation by opening the sac and performing an obliterative or reconstructive aneurismorrhaphy (Matas), as conditions allowed. Owing to the scalenus anticus being incorporated in the wall of the sac,



## LIGATURE OF THE INNOMINATE ARTERY

this procedure was abandoned. The first part of the subclavian was very short and inaccessible and eminently unsuited for the application of a clamp. I do not think it advisable to apply a permanent ligature, because of the unsatisfactory results that usually follow such a procedure. If I could have controlled the circulation through it temporarily and at the same time controlled the circulation through its branches, particularly the vertebral, I should have attacked the aneurism directly by the open method. But without full control I was afraid that too much blood would reach the aneurismal sac through these branches to justify such a heroic procedure. It was a great disappointment not to be able to open the sac and turn out the clots, because such a procedure would have relieved the pressure instantly on the tissues outside the aneurismal sac, and allowed the blood to pass along the collateral channels with greater ease. I was convinced that any handling of the first part of the subclavian was unwise, because of possible permanent injury to its branches, which were necessary to carry on the collateral circulation. Ligature of the innominate seemed the only course to follow. There was no reason to fear for the life of the arm because both the vertebral artery and the common carotid were left intact, and it was confidently expected that enough blood would flow downward along these vessels to keep the arm alive. It was probably wise, in this particular instance, not to have ligatured the common carotid. The collateral circulation outside the aneurism was seriously embarrassed, and it is quite probable that the vertebral and inferior thyroid alone would have been unable to have supplied the arm with enough blood to keep it alive. The possibility of distal ligature never entered into our calculations. Only the brachial artery was accessible; and ligature of this trunk would have been fatal to the life of the arm. If the third part of the axillary artery had been accessible and a ligature could have been applied *above* the origin of the subscapular artery, a satisfactory result might have followed without imperilling to any great extent the collateral circulation.

### IMMEDIATE RESULTS OF LIGATURE OF THE INNOMINATE ARTERY

The primary object of ligature of an artery is to cut off the blood current through the aneurismal sac and promote clotting in its interior. If the innominate artery alone is ligatured, there will always be a possibility of blood flowing downward along the carotid of the same side into the subclavian artery. Blood may also reach the subclavian in a reflux manner from the vertebral. A fair amount of blood will also reach it through the anastomotic channels derived from the other branches of the first part of the subclavian.

Under ordinary circumstances there is not much likelihood that the upper extremity will be deprived of its blood supply to a degree sufficient to jeopardize its vitality. Rather is there a fear that too much blood will flow through the aneurismal sac and that consolidation will not occur. With this possibility in view, some surgeons place a ligature on the common carotid, while others obliterate both common carotid and vertebral at the time of the primary operation on the innominate. It would appear, however, from theoretical considerations, that these additional ligatures would place the circulation of the upper extremity in greater jeopardy. If consolidation of the aneurism occurs, no blood can pass into the upper limb by the direct route (*i.e.*, *via* the subclavian artery, the aneurism and the axillary artery). It must pass by the anastomoses. A study of the anastomotic channels (Fig. 4) should be made under two conditions: (1) With the carotid and vertebral still patent; (2) with one or both of these arteries tied. In the *former* the first part of the subclavian remains an active part of the direct arterial system, owing to the large quantity of blood flowing backward into it along the lumina of the carotid and vertebral arteries. Blood passes freely into its branches, and, if consolidation occurs in the aneurism, the supra-scapular, possibly the posterior scapular, and the superior intercostal arteries will serve as the chief anastomotic channels to carry blood into the branches of the axillary artery below. In the *latter* condition, where one or both arteries are tied, the first part of the subclavian is partially or completely cut off from the arterial system. It is true, after ligature of both arteries, that a feeble trickle of blood may reach it as a reflux from the inferior thyroid; but there will not be enough to fill the supra-scapular which is perhaps the most important of all the anastomotic trunks. In such a case the circulation of the upper limb will be greatly imperilled, for it is hardly to be expected that in a large axillary and subclavian aneurism the anastomoses between the thoracic branches of the axillary artery and the intercostal arteries would suffice to carry enough blood to the arm. Therefore, it would appear to be a dangerous procedure to add to a ligature of the innominate, simultaneous ligature of both carotid and vertebral. One of these trunks should be left free to carry blood into the first part of the subclavian and its branches. The vertebral alone seems able to supply this want, as simultaneous ligature of the innominate and carotid have been performed many times without seriously affecting the vitality of the upper extremity.

What effect will the additional ligature of the carotid have on the cerebral circulation? Ligature of the innominate artery alone cuts off the direct flow of blood to the right side of the brain through the internal carotid and vertebral arteries. Not only does the current in these

## LIGATURE OF THE INNOMINATE ARTERY

blood-vessels towards the brain cease, but a reverse current starts in them toward the upper extremity which is in sore need of blood. In this manner, some of the blood circulating through the circle of Willis is diverted from the right side of the brain, and instead of passing terminally in full bore along the terminal cerebral branches of the carotid and vertebral, reaches the nervous centres in less volume. It would be much better for the cerebral circulation if this loss could be prevented, and, arguing from a theoretical stand-point, ligature of the common carotid and vertebral would benefit the cerebral circulation.

From the above facts we may conclude that ligature of the carotid serves a double purpose, viz.: (1) to diminish still further the flow of blood through the aneurism and promote consolidation; (2) to prevent an excessive drain of blood from the circle of Willis and avoid cerebral anæmia. Therefore, it may be concluded safely that the practice of simultaneous ligature of the innominate and the right common carotid is founded on sound reasoning.

*Status of the Operation.*—I have been able to find authentic references to 52 cases of ligature of the innominate artery in which there were 16 recoveries, i.e., 30.7 per cent. The information has been gleaned mainly from three papers, one by Sheen, published in 1905, in which he collected 36 cases; another by Burns,\* in 1908, who added 7 more; a third by Hamann in 1914, who added 7 more. In addition I have been able to find references to one other case beside the one reported above, making two more.

As far as the histories of the cases enable us to judge, out of the 52 cases collected, there were 41 cases of spontaneous aneurism, 6 cases of traumatic aneurism, and 5 cases of wounds of the large arterial trunks. The recoveries were distributed as follows:

	Cases	Recoveries
Spontaneous aneurisms .....	41	12
Traumatic aneurisms .....	6	2
Wounds of arterial trunks.....	5	2
	—	—
	52	16

It is interesting to note that the two recoveries in traumatic aneurisms were reported in 1906, by a Japanese surgeon, Saigo. One case was a traumatic aneurism of 40 days' duration, of the right common

\* Burns in his paper claims to have collected ten new cases. Two of his cases, viz.: by G. H. Porter and T. Annandale in table No. 4, p. 1674, had been reported previously by Sheen in his table of "cases of attempted ligature," p. 23. A third case attributed to Miles (also in table 4), I have been unable to find and have therefore not thought it wise to include it.

JAMES E. THOMPSON

carotid artery, resulting from a gunshot wound. Ligature of the innominate failed to cure the aneurism. Nine months later the aneurism was cured by excision. The other case was a traumatic aneurism of the right subclavian. Ligature of the innominate seems to have been successful, but neuralgic pains persisted. The case was eventually cured by excision of the aneurismal sac after double ligation of both subclavian artery and vein on each side of the sac.

The recoveries after wounds of arteries comprise two cases. The one reported by Lewtas (Sheen No. 28) was a wound of the subclavian, caused a month previously by the bursting of the breech of a rifle. The piece of steel was lodged above the clavicle. There had been bleeding from the wound three days before admission. When the steel was removed a profuse hemorrhage occurred. This was stopped by pressure. The innominate and carotid were tied and bleeding ceased. The other reported by Hernandez gives very meagre details. An injury was received at the origin of the right carotid which necessitated ligature of the innominate. Recovery followed.

Careful analysis of all the cases reported seems to show that simultaneous ligature of the carotid and innominate is followed by a smaller mortality than ligature of the innominate alone.

The following summary explains this in a graphic manner.

SUMMARY OF TOTAL NUMBER OF CASES

	Cases	Recoveries	Deaths
Ligature of the innominate alone .....	35	7	28
Ligature of the innominate and carotid simultaneously .....	15	9	6
Ligature of the innominate, carotid, and vertebral simultaneously .....	2	0	2
	—	—	—
Total .....	52	16	36

As a large number of these cases (21 in number) were reported before the year 1880, I have analyzed the cases published since that date, which we may presume fall in the antiseptic period.

The results are more striking even than the former.

SUMMARY OF CASES OPERATED UPON SINCE THE YEAR 1880

	Cases	Recoveries	Deaths
Ligature of the innominate alone .....	17	7	10
Ligature of the innominate and carotid simultaneously .....	12	8	4
Ligature of the innominate, carotid and vertebral simultaneously .....	2	0	2
	—	—	—
Total .....	31	15	16



## LIGATURE OF THE INNOMINATE ARTERY

It will be seen that the percentage of recoveries after ligature of the innominate alone is 41.2 per cent. as against 66.6 per cent. after simultaneous ligature of the innominate and carotid. Simultaneous ligature of the three trunks seems to have been very disastrous. It is probably rather unwise to draw hard and fast conclusions from the figures shown above, because so many factors enter into the causes of success and failure that cannot be gleaned from any published case. So much depends on the pathological condition of the artery tied, the state of the collateral circulation, the dexterity of the operator, the cleanliness of the operation and the condition of the patient, that statistics must be accepted with the greatest caution.

### ABSTRACTS OF ALL CASES REPORTED SINCE SHEEN'S ARTICLE WAS WRITTEN

36. SHEEN, WILLIAM (1905) (*ANNALS OF SURGERY*, July, 1905): Patient admitted into Cardiff Infirmary in February, 1904. Aged forty-six years. Alcoholic but no history of venereal disease. Occupation, a laborer. Had previously served in the army.

*Diagnosis:* Spontaneous aneurism of the right subclavian artery, mainly occupying the third part. *Operation* (March 31, 1904): An attempt was made to secure the first part of the subclavian artery through a vertical incision near the middle line. The common carotid was identified and followed downward. The pleura was wounded (?) and ligature of the first part of the subclavian abandoned. The innominate was tied with floss silk, two ligatures being used side by side (Ballance's stay knot). The common carotid was also tied. Pulsation in the aneurism ceased at once. The patient was restless for two days, but eventually made a good recovery. Pulsation returned in the aneurism on the day following the operation. Its intensity varied from time to time, but never became so forcible as before the operation. The pain down the arm and the other pressure symptoms continued. The *second operation* was performed on May 19. An attempt was made to ligature the innominate on the cardiac side of the first ligature. An alarming gush of blood caused the operation to be abandoned. The *third operation* was performed on June 2. The scalenus anticus was identified and its outer edge carefully dissected. A small healthy portion of the subclavian artery was exposed between the muscle and the upper part of the aneurism. The phrenic nerve was retracted and the outer part of the scalenus anticus was divided. Two ligatures were then placed on the artery proximal to the aneurism, one on the second part of the subclavian, the other on the third part close to the aneurism. Pulsation ceased and the patient was entirely cured.

37. GAY, G. M. (1897) (*Boston Med. and Surg. Journ.*, 1897, v. 137, p. 73): Female, aged thirty-nine years.

*Diagnosis:* Spontaneous aneurism involving the innominate, carotid and subclavian arteries, of two years' duration. The innominate artery was tied with three braided silk ligatures placed at different levels. The wound became septic and secondary hemorrhage occurred on the thirty-second day. The common carotid artery was tied but no effect was produced on the bleeding. The patient died ten days afterwards.



38. HARTE, RICHARD H. (1897) (*ANNALS OF SURGERY*, Philadelphia, 1897, v. xxvi, p. 488): Male, aged twenty-six years. Patient had received a pistol wound of the neck, the bullet entering about one inch above the inner end of the left clavicle. There were evidences of injury of the fifth cervical nerve. The bullet was located on the right side of the neck in front of the cervical vertebrae. The bullet was removed by an incision along the posterior border of the right sternomastoid. It lay alongside the oesophagus and behind the origin of the right common carotid artery. On the third day, swallowed fluids regurgitated through the wound. On the eleventh day, bleeding occurred which was easily controlled. Two days afterwards severe hemorrhage occurred. A search was made for the bleeding point. The opening appeared to be on the posterior side of the right common carotid. A ligature was placed on the carotid proximal to this apparent opening but the bleeding still continued. The clavicle was dislocated and the innominate searched for. Before ligating this vessel another ligature was placed on the carotid close to its origin. This stopped the bleeding. Ten days later another hemorrhage occurred. The innominate was exposed and ligatured just before it bifurcated. The carotid and subclavian were also ligatured. The patient died in a few hours. (The position of the ligature placed on the carotid and subclavian in the last operation is not clear. The account of the postmortem examination does not give any information as to the blood-vessel originally wounded.)

39. MOYNIHAN, B. G. A. (1898) (*ANNALS OF SURGERY*, Philadelphia, 1898, vol. xxviii, p. 1): Male, aged thirty-one years. Diagnosis was spontaneous aneurism of the third part of the subclavian artery. On December 8, 1897, the aneurismal sac was excised. This was accomplished apparently without any injury to the subclavian vein. To facilitate the operation, the clavicle was divided in two places and the middle half thrown down. Unfortunately, the wound became infected. On December 20, there was an escape of an ounce of blood. A suppurating axillary gland was opened on January 9. Afterwards the case progressed favorably, until February 6. On this day a hemorrhage occurred under the flap raised in the original operation. Bleeding was checked by a pad and bandage. On February 8, a fresh hemorrhage occurred. Exploration of the subclavian triangle revealed a large clot of blood. On clearing this away, a terrific hemorrhage resulted. The innominate and carotid were tied with silk ligatures. Death occurred in about an hour. The postmortem revealed a rupture of a second aneurism which existed on the posterior wall of the first part of the subclavian, about one inch from the end of the ligatured vessel.

40. SCHUMPERT, T. E. (1898) (*New York Med. Record*, September 3, 1898, p. 337): Female, aged forty-two years. *Diagnosis*: A spontaneous aneurism arising probably from the termination of the innominate. A braided silk ligature, No. 8, was tied around the innominate artery proximal to the aneurism. The patient died of cerebral anæmia on the ninth day after the operation.

41. HERNANDEZ, ALBERTO (1900) (*Wien. med. Blatt*, 1900, v. xxiii, No. 35, p. 559): For an injury at the origin of the right common carotid the innominate artery was ligatured with a successful result.

42. DE LAUP, S. P. (1901) (*Phila. Med. Journ.*, 1901, v. vii, January 26, p. 171): Male, aged fifty-eight years. *Diagnosis*: Subclavio-axillary aneurism

## LIGATURE OF THE INNOMINATE ARTERY

of the right side. The operation was performed on June 16, 1900. The entire third portion of the subclavian artery was occupied by the aneurism. Excision of the inner end of clavicle and sternum revealed a fusiform aneurism of the innominate in addition. The innominate artery was ligatured about one inch from its origin. Two ligatures of kangaroo tendon and one of braided silk were used. Death occurred on the operating table.

43. BURNS, W. B. (1908) (*Journ. Amer. Med. Assn.*, November 14, 1908): Male, aged twenty-seven. *Diagnosis*: Spontaneous aneurism occupying the third part of the right subclavian artery. The hand and arm were cedematous and numb. He complained of severe pain in the shoulder. *Operation* (August 9, 1907): The innominate artery was exposed by the Mott incision and tied with thick braided silk (pedicle silk) at a point about one inch proximal to its bifurcation. Pulsation ceased immediately and did not return. The wound suppurated. On August 22, a hemorrhage occurred from the wound which was controlled by packing. On August 24, another small hemorrhage occurred. On August 26, this was repeated. After this, convalescence was uneventful. On September 30, the silk ligature was removed from the wound.

44. SAIGO, K. (1906) (*Deutsche Zeitschr. f. Chir.*, v. 85, ss 577-640): Patient was a male, aged twenty-two. He was shot in the neck on October 14, 1904. An aneurism developed in the common carotid artery. On November 23, 1904, the operation was performed. After resection of the inner end of the clavicle and part of the sternum, the innominate artery was tied. The aneurism reappeared. On August 11, 1905, the common carotid artery was tied above and below the aneurism, which was then resected. Cure.

45. SAIGO, K. (1906) (*Deutsche Zeitschr. f. Chir.*, v. 85, ss 557-640): Case of a male, aged twenty-five years. Shot above the right clavicle on March 5, 1905. A traumatic aneurism developed. On April 6, 1905, the innominate artery was ligatured in two places and divided between the ligatures. Aneurism was not cured and pains continued. On August 4, 1905, the aneurism was excised after ligature of both subclavian artery and vein, proximally, and distally. Recovery.

46. MYLES, SIR THOMAS (1907) (*Dublin Journ. Med. Sci.*, v. 124, pp. 474, 475): Case of a male, aged twenty-nine. *Diagnosis*: Spontaneous aneurism of the right subclavian artery. *Operation*: Ligature of the innominate artery and simultaneous double ligature of the common carotid with division of the trunk. Bleeding occurred into the wound ten days after operation. The bleeding vessel (not identified) was ligatured. Repeated hemorrhage, suppuration. Death one month after the operation. Autopsy showed that hemorrhage was from carotid artery.

47. SARGENT, P. (1911) (*Lancet, Lond.*, May 16, 1911, p. 120): Woman, aged sixty-seven. *Diagnosis*: Spontaneous aneurism of the first part of the right subclavian artery or of the innominate at its bifurcation. *Operation* (September 14, 1909): After removal of the greater part of the right half of the manubrium sterni and part of the right first costal cartilage, the innominate artery was exposed without difficulty. The ligature consisted of floss silk tied in a "stay" knot. The common carotid was also tied at the level of the cricoid cartilage, No. 2 braided silk being used. Pulsation in the aneurism ceased at once. No

cerebral symptoms were noticed. On the sixth day slight pulsation reappeared in the sac. On the ninth day pulsation disappeared. On the tenth day weakness in the left arm and face were noticed for the first time. No loss of power was noticed in the left leg. The weakness soon passed away. The patient was seen in June, 1910, and was in fine condition. No weakness was found in the arm, face or leg, and no pulsation was found in the aneurism. She remained well until the early part of 1911, when she died of chronic nephritis and pneumonia. The pathological specimen was obtained and it showed complete obliteration of the innominate and carotid between the ligatures and obliteration of the first part of the subclavian almost as far out as the origin of the vertebral.

48. BALLANCE, C. A. (1912) (*Proc. Roy. Soc. of Med.*, Lond. Clin. Sec., vol. v, p. 99): Case of a male, aged forty-three. *Diagnosis*: Spontaneous aneurism of eighteen months duration of the right subclavian artery. *Operation*: Ligature of the innominate artery with two strands of kangaroo tendon. During operation it was found that the aneurism covered the first part of the subclavian which was inaccessible. Recovery.

49. BALLANCE, C. A. (1912) (*Proc. Roy. Soc. of Med.*, Lond. Clin. Sec., vol. v, p. 99): He mentioned, during the discussion of the case above reported, another which came under his care two years previously, suffering from a large right subclavian aneurism. It suddenly began to extend. Part of the manubrium was resected and the right clavicle and first and second ribs were divided. The aneurism overlapped the innominate artery, which, however, was ligatured. Pulsation in the aneurism ceased immediately. While getting ready to close the wound, the aneurismal sac burst and there was a sudden gush of blood. A finger was passed into the sac and the hole plugged. Finally the sac was plugged with gauze. The patient died on the following day.

50. HAMANN, CARL A. (1914) (*ANNALS OF SURGERY*, June, 1914, p. 962): Woman, aged sixty-eight years. *Diagnosis*: Spontaneous aneurism of the third part of the right subclavian artery. No disturbance of circulation except pain and paræsthesia. First treatment consisted of the insertion of 8 inches of fine silver wire into the sac. No improvement followed. Operation was performed on February 10, 1913. The aneurism was exposed and was found to involve mainly the third part of the subclavian, and to encroach also on the second and part of the first portion of the artery. The innominate was exposed after resection of two inches of the inner end of the clavicle. A heavy braided double silk ligature was placed about half an inch below the bifurcation and tied with an ordinary surgical knot. The common carotid was tied about an inch above its origin with No. 2 chromicized catgut. No unfavorable circulatory troubles made their appearance after the operation. The wound healed by first intention. The sac became consolidated and firm. Cure was complete thirteen months later.

51. MORRISON, RUTHERFORD (1914) (*Brit. Journ. Surgery*, April, 1914, p. 725): Male, aged fifty-one years. *Diagnosis*: Spontaneous aneurism of the third part of the right subclavian artery. There was excruciating pain in the shoulder with numbness and loss of sensation down the right arm. There was œdema and venous engorgement of the arm and forearm. *Operation* (July 20, 1912): The intention was to put a temporary ligature on the innominate

## LIGATURE OF THE INNOMINATE ARTERY

and treat the aneurism by the Matas method. While cleaning the innominate, a hole was accidentally torn in its outer side. The vessel was then tied below this with soft, thick silk ligature. The right common carotid was tied with catgut. A piece of fascia lata taken from the thigh was wrapped around the ligatured vessels. After the operation pulsation ceased and the agonizing pain had gone. There was complete anæsthesia and paralysis of the arm. This gradually passed away.

52. THOMPSON, JAMES E. (1914): Case reported in this communication.



## TRANSPLANTATION OF ENTIRE BONES WITH THEIR JOINT SURFACES\*

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THE following experiments in bone transplantation were undertaken to determine whether or not it is possible to secure the healing in of entire bones with their articular surfaces, and whether or not such bones, if they do become healed in, will remain alive and unabsorbed, and, finally, to observe any other conditions that may have a bearing upon the subject of bone transplantation in general.

Full-grown dogs were operated upon under complete surgical anæsthesia by ether. The second long metatarsal bone was excised in the front paws and each one was implanted in the opposite paw. The ends of the bone were held in position by chromic catgut sutures. Tendons and fascia were sutured over it with interrupted sutures of silk floss. Asepsis was attempted by shaving the paws and painting the skin with tincture of iodine and by clamping the margin of the incision to sterile towels. After the incision was closed it was painted with tincture of iodine. No dressings were applied and the dogs were permitted to walk about. This they usually did on the day following operation without any evidence of pain.

*Experiment No. 1.*—Operation January 30, 1914. Periosteum scraped from the bone implanted in the right paw. Both skin wounds broke down a few days after the operation. The left paw was entirely healed on February 18, but the right presented a discharging sinus. On March 9, the exposed metatarsal was removed from the right paw under ether anæsthesia. April 4, both paws healed, dog walks and runs on both feet without a limp. October 16, dog killed. X-ray picture of paws shows the metatarsal present in left paw. Marrow cavity narrowed and irregular but persistent throughout the length of the bone except at proximal end, which shows evidence of the suppuration that occurred after the operation. The metatarsophalangeal joint is apparently normal. In the right paw only about one-half of the distal extremity of the transplanted bone remains.

*Experiment No. 2.*—Operation February 19, 1914. February 24, both wounds wide open to the fascia. February 26, dog killed, as a part of the left transplant was exposed. The other half of it was found to be firmly embedded in granulation tissue which was firmly adherent to the bone except at the joints. The other transplant was completely embedded in granulation tissue which was

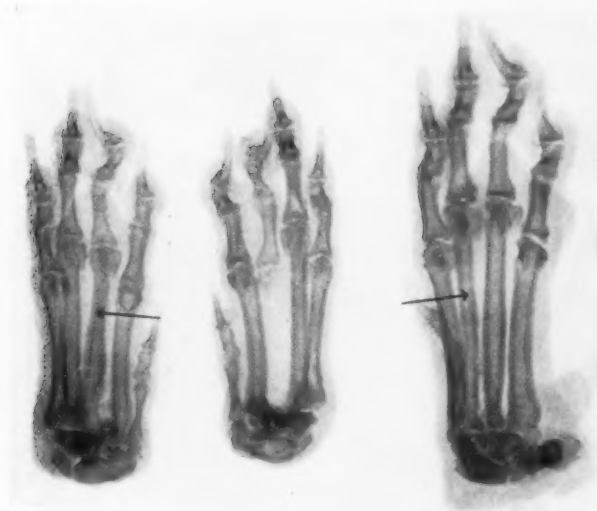
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\* Read before the Philadelphia Academy of Surgery, February 1, 1915.





FIG. 1.—Experiment No. 1.



No. 3.

No. 4.

FIG. 2.—Experiments No. 3 and No. 4.

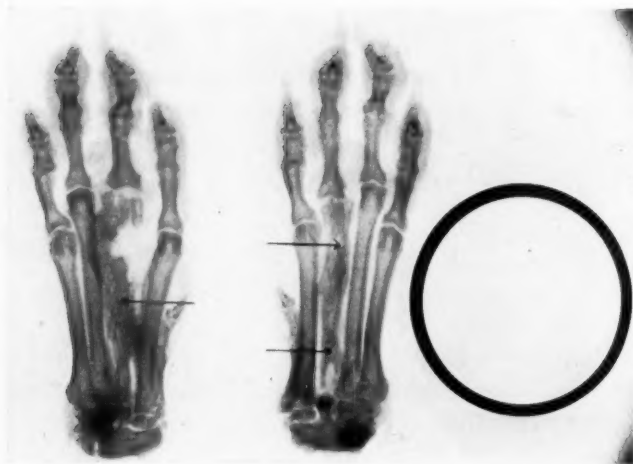


FIG. 3.—Experiment No. 5.



FIG. 4.—Experiment No. 6.

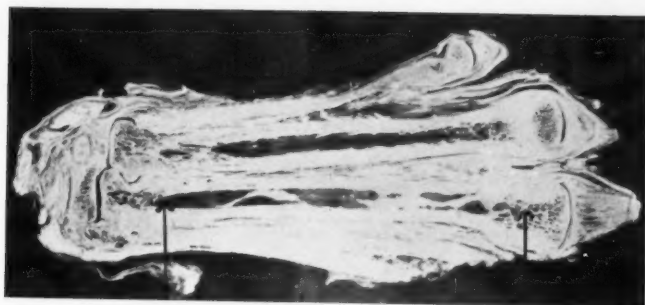


FIG. 5.—Photograph of section of paw.



FIG. 6.—Photograph of section of paw, mounted in celloidin.

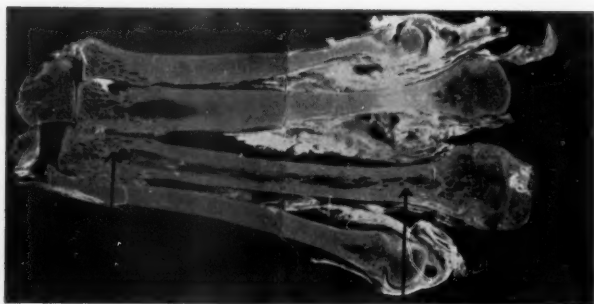


FIG. 7.—Photograph of section of paw.

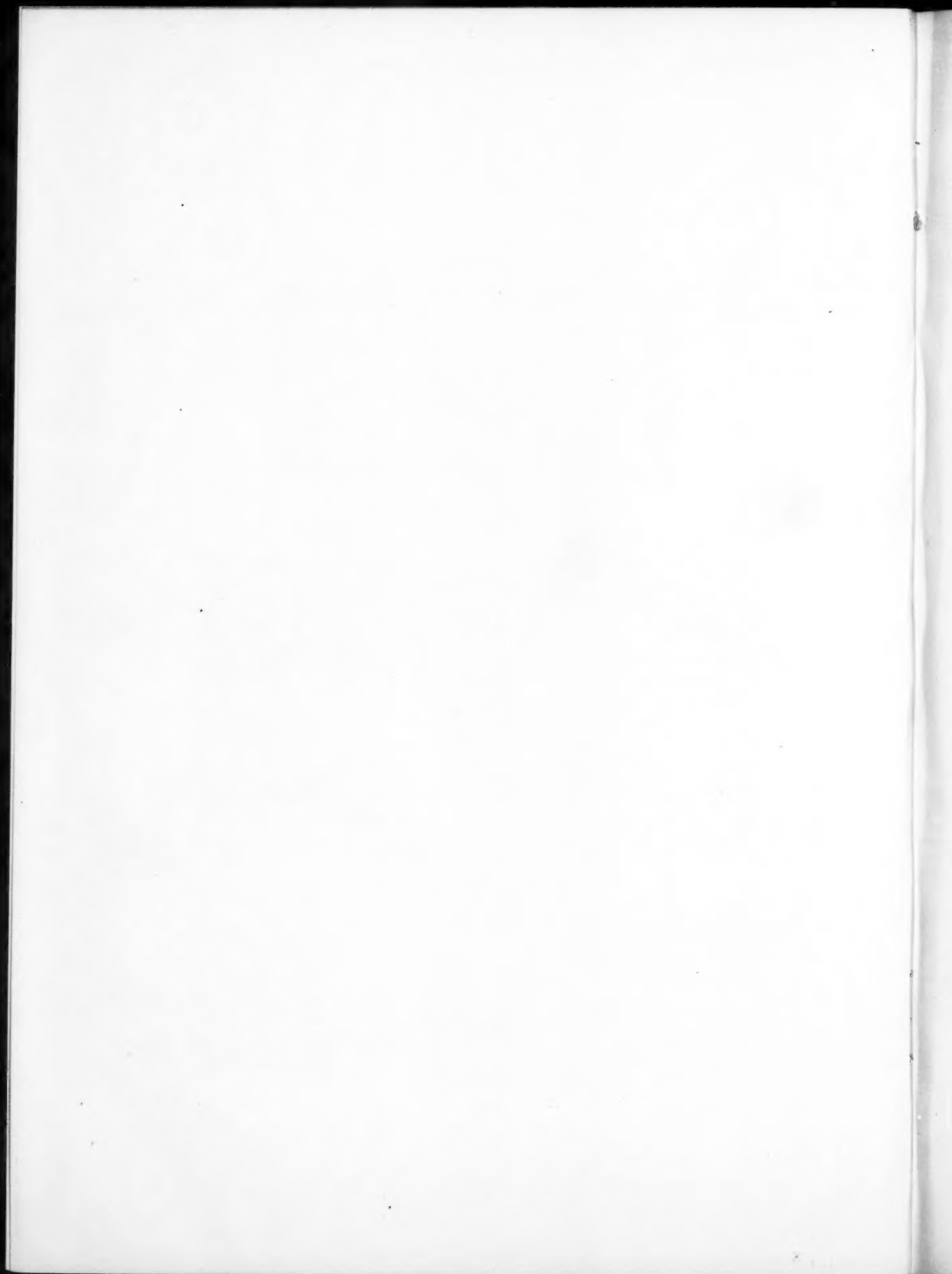


FIG. 8.—Photograph of section of paw, mounted in celloidin.



FIG. 9.—Microphotograph of transplanted bone, showing joint cartilage above and bone below.  
Cells of both are well stained.





## TRANSPLANTATION OF ENTIRE BONES

firmly adherent to the bone except at the joints. The bone was torn out with considerable force, and soft tissue remained clinging to it.

*Experiment No. 3.*—Operation February 25, 1914. One metatarsal broken in removal and not implanted. March 17, small sinus present. Dog walks without limp. May 6, small persistent sinus. June 15, healed. October 16, dog killed. X-ray shows transplanted bone present and apparently normal, except for slight irregularity in proximal end. Both joints apparently normal.

*Experiment No. 4.*—Operation February 26, 1914. March 9, skin wounds open to the fascia, right discharging pus. March 17, almost healed. Dog has distemper. April 29, small sinus in right paw, left remains healed. May 6, right paw healed. October 16, dog killed. X-ray of left paw: Transplanted bone all absorbed except small distal fragment. Right paw: the bone is present, marrow cavity very narrow, proximal half of bone thick and irregular. Distal joint normal, proximal joint obscure. The other metatarsals and the tarsal bones also present evidence of the suppurative process.

*Experiment No. 5.*—Operation March 18, 1914. March 25, wounds both open to the fascia. April 2, wounds healed above and open below. April 29, suppuration in both paws. October 9, healed. October 23, dog killed. X-ray of left paw: Transplanted bone shows marked evidence of the long suppuration; thickened, irregular, proximal end absorbed for about one-fourth inch. Right paw: Bone much distorted, proximal ends of two other metatarsals also slightly involved. Distal joint good.

*Experiment No. 6.*—Operation March 19, 1914. March 25, left is healed, did not break down. Right is open below. April 2, both healed, no lameness. October 23, dog killed. X-ray of left paw: Transplanted bones present, a little thinner than normal; proximal extremity a little irregular, otherwise like other metatarsals, dislocation of distal joint. Right paw: Transplanted bone apparently normal throughout.

*Summary.*—Eleven bones were transplanted. One dog was killed a week after operation, before healing in of the bones had occurred, and in another dog one transplant was removed under ether. The remaining eight transplants healed in after more or less suppuration of all wounds but one. The dogs were killed from seven to eight and one-half months after operation. One of the eight healed-in transplants was found to be almost all absorbed. Another is badly distorted and a second moderately changed as a result of osteomyelitis following operation, but they appear to be serving their function and they present evidence of new bone formation. The remaining five transplanted bones are practically normal in appearance. The articular ends of the bones are apparently normal and the joints have perfect function except in those cases where the end of the bone was destroyed by the suppurative process.

Microscopic examination of the transplanted bones that healed in with little or no suppuration of the wounds shows no evidence of dead bone anywhere. The bone cells as well as the cells lining the marrow

cavity and the cells of the periosteum are well stained. If there was necrosis of the transplanted bone, the necrotic part has all been absorbed and replaced. The joint cartilage also appears normal.

The operations were performed by the writer without assistance. This rendered it necessary to fasten the paws of the dogs securely to blocks of wood. The straps caused venous constriction which prevented complete hæmostasis and delayed the operations. These conditions probably caused the breaking down of the wounds and the subsequent suppuration. In experiment No. 6 this condition of venous constriction was avoided and the one paw healed by first intention and the other healed promptly after it had opened up slightly. I believe that practically all cases could be operated upon with primary union under favorable conditions and consequent healing in of all transplanted bones.

The fact that so many of them healed in under unfavorable conditions and in the presence of infection shows the marked resistance of the transplant. The articular ends of the bones and the joint cartilage show an equal ability with the remaining portion to maintain their life and resist infection. In these experiments the joints emerged from their trials in fully as good condition as the bones proper, and it should follow that the transplantation of half-joints and entire joints should present no greater difficulty or uncertainty than the simple transplantation of bones of equal size.

The fact that the dogs went about on their paws almost immediately following the operation does not necessarily affect the transplanted bone adversely. To the contrary, the functioning of the transplant may be a favorable factor in its life and regeneration.

These experiments would seem, therefore, to indicate that the smaller long bones with their articular surfaces are readily transplantable in the dog under unfavorable conditions, and that the joints are re-established and preserved thereafter.

In the successful transplantations the bones are found at the end of seven to eight and one-half months to be normal in outline and structure, to be living and to show no evidence of necrosis or absorption of any of their parts, in short, to be indistinguishable from normal bone. They have not been in contact with other bones except through their articular surfaces. We must therefore conclude either that the transplanted bone has retained life in itself or that it has been completely regenerated in all of its parts by a process of metaplasia of cells derived from the surrounding soft tissue. Murphy's theory that

## TRANSPLANTATION OF ENTIRE BONES

a transplanted bone is only osteoconductive and that it must contact with fresh living bone is absolutely inapplicable to these experiments.

The metaplasia theory of bone regeneration from the surrounding connective tissue cells is maintained by Baschkirzew and Petrow, whose views, based on animal experimentation and clinical observations, are entitled to some consideration, if only to expose their fallacy. They state that the majority of bone transplants soon die: although a few stronger or better nourished ones may live a long time, until they also die of exhaustion. Some few heal in and regenerate new bone. Young connective tissue cells are the chief factor in the regeneration of new bone in a transplant which is imbedded in muscle. They penetrate into the vascular and the Haversian canals and are converted into osteoblasts and bone cells. The transplanted periosteum and endosteum become in part necrotic, while the remaining part is possibly capable of bone regeneration. But the persistence of such new bone is questionable and its differentiation from the bone which grows from the connective tissue cells is often impossible. The preservation of the periosteum is not essential to the life of the transplant, but it evidently is useful in causing more rapid union between the transplant and the surrounding tissues, in hindering resorption of the transplant, and in giving the first impulse to new bone formation.

This view of metaplasia does not agree with the views of most other investigators of this subject. Nor, if pushed to the limit, does it seem tenable. If the entire transplant has died and if later we find the transplant to be alive, then it is necessary to suppose that all its parts, periosteum, marrow, endosteum, bony tissue, have been regenerated from young connective tissue cells from the surrounding structures. But if these tissue cells are capable of such metaplasia, why do they not perform such function at all times, why do they wait until a dead transplant is thrust into their midst, or why do they not do it when a piece of decalcified bone or other porous substance is implanted? It becomes necessary to suppose that in some unaccountable manner the dying transplant stimulates the metaplasia. The same process must necessarily occur in every simple comminuted fracture. And all this theory in the face of the fact that bone contains within itself the elements necessary to its growth and regeneration. Why then should it borrow from the outside?

As a matter of fact, Baschkirzew and Petrow do not push their theory to its rational conclusion. They admit that certain parts of the transplant do regenerate new bone, but say that such bone often cannot be differentiated from the bone which grows from the connective tissue

cells. How then can they differentiate the latter from the former? Finally, the thorough microscopic studies of Phemister, Mayer and Wehner and many others show that certain parts of the transplant are osteogenetic. The latter investigators give careful consideration to Baschkirzew and Petrow's theory and point out the errors in their experiments in not excluding bone derived from the osteogenetic layer of the periosteum and from adjacent Haversian canals.

All the evidence and all the weight of authority is against the view of regeneration by metaplasia. We must conclude that a transplanted bone retains life in itself and is capable of its own regeneration as far as is necessary.

For clinical purposes this is all that is necessary to be certain of in the transplantation of bones. And yet it may be of value to know, for example, whether or not we should remove the periosteum from the transplant. This opens up to us the entire question of the rôle played by each part of a bone transplant, what parts live and what parts die, what parts regenerate bone and what do not.

At first view one is confused by the opposing views of such men as Barth and Murphy, Axhausen, Macewen, and Baschkirzew and Petrow with their numerous followers or predecessors. Their views are often diametrically opposed and they cannot all be right. But much of this confusion will disappear on careful study and comparison of the various statements and theories, and I think we are able at the present time to arrive at conclusions fairly close to the truth.

In the first place, certain words, such as periosteum, marrow, bone graft, do not have the same meaning and content to all writers on this subject. When Macewen and others state that they have removed the periosteum in certain experiments they mean that part of the periosteum which is easily stripped from the shaft of the bone. But Mayer and Wehner and various histologists have shown that the cambium, or osteogenetic layer of the periosteum, which Macewen ignores or denies to exist, is applied so closely to the bone and so penetrates into the bony canals, particularly at the cancellous ends of the long bones, that it cannot all be removed even with a rasp. This fact must vitiate practically all such experiments unless it has been microscopically proved that there has been no osteogenetic layer of the periosteum left on the transplant.

Again, when Axhausen speaks of bone regeneration from marrow or medulla, he means regeneration from the endosteum which lines the marrow cavity and the Haversian canals. Like the periosteum this too cannot be completely stripped from the bone.



## TRANSPLANTATION OF ENTIRE BONES

Likewise, there is some confusion in the use of the term bone graft. In some cases it means all the parts of a bone from periosteum to marrow, and again it means only the compact bony tissue, and frequently its meaning is not stated or indicated. When Gallie says a bone graft always dies, he is speaking of one probably without periosteum and with little or no endosteum.

In the second place the views of certain writers have been somewhat modified and we must consult their most recent utterances. Axhausen at first stated that bone regeneration occurs only from the periosteum, but he now maintains that the marrow, or endosteum, and joint cartilage are likewise transplantable, *i.e.*, they remain living and are capable of regeneration. Albee at first stated that a bone graft without periosteum is as good as one with it, but now he is careful to retain both periosteum and endosteum in the graft.

And, finally, most authors have disregarded Roux's law of functional adaptation. The final result of a bone transplanted into soft tissues where it bears no weight and serves no other function may be entirely different from that of a bone placed where it will serve a mechanical function. Function stimulates growth and regeneration both in normal and in transplanted tissues.

Let us now examine very briefly the various theories of bone transplantation. The old theory of Barth, recently restated by Murphy and others, that a bone transplant always dies and is absorbed and is replaced, if it be replaced, by bone from the recipient or contacting bone, must be definitely rejected. It is based on insufficient and defective evidence and is directly disproved by a large mass of experiment by Axhausen, Ollier, Albee, McWilliams, Nicholls, Phemister, Cotton and Loder, Hass, Lexer, Mayer and Wehner, Tomita, Trinci and others. In the experiments of the writer the transplanted bones did not contact with other bone except through their joint surfaces, which, of course, effectively prevent osteoconduction. The recent study of Gallie need not be considered as corroborative of the above theory, as it merely shows that some bone grafts without periosteum and with little or no endosteum may die and be replaced by bone from the recipient bone.

Macewen believes that the bone cells of the transplant occupying the lacunæ of the bony substance itself are the active agents in the life and regeneration of a transplant, and that the periosteum is only a limiting membrane and takes no part in osteogenesis. He makes the mistake of presenting no microscopical evidence and of entirely neglecting the consideration of the cambium layer of the periosteum. His experi-

ments are all open to a misunderstanding because he does not exclude the possibility of bone formation from this structure, nor, moreover, from the endosteum and the lining of the Haversian canals. It would appear from the work of Axhausen, Phemister, McWilliams, Mayer and Wehner, and others that part of the bony substance of a transplant may live indefinitely although most of it soon dies, and it seems even possible that there may be regeneration from some of the bone cells which receive early and sufficient nutrition after the transplantation. Therefore, Macewen may have been partly correct in stating that the bony substance including Haversian canals lives and regenerates. But such regeneration must be far less than he supposed it to be, as it is now proved unquestionably that the preponderating part of regeneration is from the periosteum and the endosteum.

McWilliams' experiments show the great value of the periosteum to the life and regeneration of the graft, in that he records 100 per cent. of successful transplantations with the periosteum, against 48 per cent. without it; but he is content to ascribe this to the influence of the periosteum in maintaining the nutrition of the graft. He fails to recognize the importance of the cambium layer of the periosteum, although he states that periosteum transplanted into soft tissues may produce new bone. And his experiments with transplants free of periosteum are open to the same criticism as most similar experiments, that frequently all the osteogenetic layer is not removed. Nor is any mention made of the endosteum, although it seems to have been present in many or all of his cases. In my judgment his studies do not support the view of Macewen that the adult bone cells of the graft are the active element in its life and regeneration; and he directly contradicts him as to the importance of the periosteum.

The metaplasia theory of Baschkirzew and Petrow has already been discussed.

There remains a consideration of Axhausen's teachings and an attempt to arrive at a true understanding of what occurs after bone is transplanted.

Axhausen, in brief, states that transplanted bone cells at first remain unchanged during an indefinite stage, and that then some cells die while others continue to live. Eventually all bone cells die and the bony tissue is replaced by regeneration chiefly from the periosteum and secondarily from the marrow. Bone tissue histologically is not transplantable. Joint cartilage, however, is transplantable both histologically and clinically, and epiphyseal cartilage is to a limited degree clinically.

## TRANSPLANTATION OF ENTIRE BONES

Axhausen's views appear, in the main, to be fairly correct according to a large number of observers, but probably he falls a little short of the truth.

I think it is no longer to be questioned that the inner, or osteogenetic, layer of the periosteum is of prime importance in the life and regeneration of a bone graft. Histologists have long taught that the periosteum is the main factor in the growth of the bone. Nicholls shows that periosteum will regenerate complete shafts of bones that have been destroyed or excised. Oechsner and others confirm this work. Ollier in 1859 showed that bone is regenerated from the periosteum chiefly and in smaller part from the cellular elements of the marrow and the Haversian canals. McWilliams says over reliance must be placed upon the periosteum.

Hass' experiments emphasize the value of this tissue and Lexer adds the weight of his authority in saying that the bony tissue of a transplant is gradually absorbed and is replaced by bone formed from the periosteum chiefly and from the medulla in part, and that the periosteum also aids in cementing the graft to the wound and in stimulating capillary invasion and early nutrition.

Jokoi produced new bone in six out of ten cases by injecting emulsion of periosteum of tibiae of young dogs beneath the skin or into the muscles.

Trinci showed that transplanted periosteum is capable of early bone regeneration.

Tomita states that new growth is from the inner layer of the periosteum and from the marrow cells.

Phemister and Mayer and Wehner confirm the periosteal osteogenesis by very painstaking and thorough experiments. In all of Murphy's published cases the periosteum was retained in whole or in part, although he states that the periosteum is not osteogenetic except when it carries osteoblasts on its inner surface.

If we view this entire process of the life and regeneration of a bone graft from the embryonal and histological point of view it seems very simple and reconciles the observations of many experimenters. The position of many of the bones is indicated in the embryo by the deposition of embryonal cartilage. But this cartilage is never directly converted into bone. It is replaced by bone formed from the osteogenetic layer of the periosteum. This layer sends bud-like extensions into the ossified centres, and proceeds to the formation of true bone. The lining of the marrow cavities, in other words the endosteum, the lining of the Haversian canals, and the external covering of the bone, the

osteogenetic layer of the periosteum, are all one and the same thing. They are continuous at least for a time and have been derived from the periosteum. This internal and external lining is a connective tissue and its young cells are only specialized connective tissue cells called osteoblasts. All bone is formed through the agency of these cells. Some of them become imprisoned by the deposition of lime salts and separated from their fellows and they are then called bone cells. These are simply adult imprisoned osteoblasts.

The remaining bones of the skeleton that are not developed in embryonal cartilage are formed directly from the osteogenetic layer of the periosteum.

When the bones of the skeleton have attained their full growth the osteoblasts of the periosteum, the Haversian canals, and the endosteum cease their activity in large part. Piersol states that "after the cessation of peripheral growth and the completion of the investing layer of compact substance, the osteogenetic layer of the periosteum becomes more condensed and less rich in cellular elements, retaining, however, an intimate connection with the last-formed subjacent bone by means of the vascular processes of its tissue, which are in continuity with the marrow-tissue, within the intra-osseous canals.

"In addition to being the most important structure for the nutrition of the bone, on account of the blood-vessels which it supports, the periosteum responds to demands for the production of new osseous tissue, whether for renewed growth or repair, and again becomes active as a bone forming tissue, its elements assuming the rôle of osteoblasts in imitation of their predecessors."

Does not this render the entire matter clear at once? Osteoblasts are present in the internal and external lining of bone and in the canals that partially connect these two linings which are thus essentially one and the same tissue. In adult bones these osteoblasts are reduced in number and are comparatively quiescent, but they are ready to respond to any demand made upon them for renewed growth or repair.

When a piece of bone or a whole bone is transplanted it is all temporarily deprived of its blood supply. But this does not necessarily mean the death of all the elements of the transplant. It would appear that in the transplantation of animal tissues the more highly specialized elements are less resistant to injury or deprivation of nourishment. Probably in bone the adult bone cell is less resistant than the young connective tissue cell, for example. Now as soon as the transplant is placed in its new position a process of re-vascularization commences. Those cells of the transplant which retain life until their source of



## TRANSPLANTATION OF ENTIRE BONES

nutritive supply is reestablished naturally can continue their life and function. Such cells probably are those which are the more resistant in themselves and which receive earliest a fresh supply of nutriment. This may reach them from the tissue juices that surround the transplant or from the blood-vessels that are reestablished in it. The cells of the transplant lying near its surface therefore would have the best opportunity for maintaining life. And the smaller the transplant, the larger is its surface in relation to its mass, and the greater is the chance for the life cells in the transplant. Macewen's observations have confirmed this. Furthermore, the cells lying along the vascular channels would have a better chance than those lying in the lacunæ of the compact bone. And the very tissue that does line the outer and inner surfaces of the bone and the Haversian canals is the osteoblastic tissue, composed of young connective tissue cells, the osteoblasts, which are just waiting for the opportunity to exercise their especial function. The adult bone cells are imprisoned in hard compact bone and are doomed to death in large part. Even if some of them do survive and live for a long time, is it their function to form new bone to take the place of that which dies?

In practically every live bone transplant, therefore, there are osteoblasts, whether in the inner layer of the periosteum which closely lines the bone and sends numerous fingers into all the canals that open on the surface and which cannot be entirely removed by stripping off the periosteum macroscopically, or whether in the endosteum of the medulla, or whether in the Haversian canals, which are simply prolongations of the medulla. Many of these osteoblasts must be favorably situated to receive nutriment, and they stand as good a chance for the preservation of life and function as any transplanted tissues ever can. Therefore Macewen can strip off periosteum in whole or in part and the osteoblasts of the medulla and Haversian canals will remain; Cotton and Loder can maintain the prime importance of endosteal proliferation; while Nicholls and Axhausen and many others can secure bone growth from the periosteum alone. But if the graft contains all three portions of osteoblastic tissue, its chances of life and development must surely be multiplied. Therefore McWilliams secures 100 per cent. of successes with the periosteum included, to only 48 per cent. without it. When Mayer and Wehner have rigidly excluded with metal caps the ingrowth of the periosteum on the surface of compact bone they have found no bone regeneration from the bone cells. Such adult bone cells probably are not capable of bone regeneration, they are no longer osteoblastic. But I am not sure that we should yet accept this state-



#### A. BRUCE GILL

ment as the final truth in all circumstances. Possibly even adult bone cells may revert to their original function under favorable or exceptional conditions.

And, finally, why need we adopt the metaplasia theory of Baschkirzew and Petrow when we have right at hand in the transplant live young connective tissue cells that have been formed and have for generations been accustomed to do just this one thing, regenerate bone.

McWilliams and Phemister in particular have dwelt upon the importance of an early and effective blood supply to the transplant. And the latter has well presented the importance of Roux's law in determining its ultimate fate. If it is in a position where bone is necessary to the welfare of the organism the transplant will survive and develop to a size necessary to its function. If it is in a useless position it will soon cease its growth and will probably be ultimately absorbed.

#### CONCLUSIONS

Certain conclusions which are of practical clinical value in surgery are readily drawn from the above experiments and discussion.

(1) Bone is only a particular form of connective tissue and is readily transplantable.

(2) It contains within itself all the elements necessary to its life, function, and regeneration provided it receives sufficient nourishment.

(3) Periosteum, medulla, and bony tissue should all be included in the graft.

(4) After transplantation the bone grows and moulds itself to perform its function efficiently.

(5) As early performance of function as is consistent with its fixation in its new position is of great advantage.

(6) A mild infection is not necessarily fatal to the graft.

(7) Transplantation of long bones with their joint surfaces is clinically possible. The inclusion of cartilage and joint surface in no way adds to the difficulty of the transplantation. While this statement is particularly true of the smaller bones, yet there seems to be no reason why as large a bone may not be transplanted with its joint surfaces as may be transplanted without such surfaces. Bier reports a large piece of tibia used to replace almost the entire shaft of the humerus, which has been under observation for 15 years. If a large bone should be transplanted it might be well to remove a portion of its shaft longitudinally in order to permit the ready access of a blood supply to the medulla.

## TRANSPLANTATION OF ENTIRE BONES

Goebel reports the successful transplantation of the proximal phalanx of the second toe to replace the proximal phalanx of the fourth finger which was removed for enchondroma. Full motion finally resulted in all the joints of the finger. A piece of cartilage from a rib was used to replace the phalanx of the toe. The X-ray showed that at the time the case was reported the cartilage had not been transformed into bone.

Katzenstein reports the implantation of the phalanx of the great toe to replace the metacarpal bone of the thumb which was removed because of tuberculosis.

Galeazzi transplanted a metatarsal bone for a metacarpal which had been removed for neoplasm. There was good function after seven years.

Sievers also transplanted a phalanx to take the place of the middle phalanx of the ring finger removed for giant-celled sarcoma.

Wolff reports a successful similar case.

Lexer in 1907 transplanted a phalanx obtained from an amputated limb.

(8) Half joints are clinically transplantable. Lexer, Küttner, Rovsing, Wolff, Enderlen, Perthes, von Haberer, Walther, and De Gouvea, have reported successful cases.

(9) Whole joints have been successfully transplanted. Lexer has had under observation for six years a knee-joint in which motion and function are perfectly free and satisfactory, although the joint shows under the X-ray certain changes similar to those found in arthritis deformans.

Goebel and Eloesser have reported each a case of implantation of a toe-joint with unopened capsule to replace a finger-joint. A big difficulty in the transplantation of large joints is in the securing of suitable material. Lexer has discarded material obtained from the cadaver and now uses that obtained from freshly amputated limbs. Buchmann has transplanted the first metatarso-phalangeal articulation into the elbow-joint in two cases.

It has not yet been demonstrated, to my knowledge, that a small entire joint can be substituted for a larger one and grow in size to meet the necessities of the joint. It may be possible that the law of functional adaptation would apply even here.

In conclusion I wish to express my gratitude to Dr. J. E. Sweet for permission to carry out these experiments in the Laboratory of Surgical Research of the University of Pennsylvania and for many helpful suggestions in conducting them.

A. BRUCE GILL

BIBLIOGRAPHY

- Albee: Jour. A. M. A., April 5, 1913; Surg., Gyn. and Obstet., June 14, 1914.
- Allison and Brooks: Surg., Gyn. and Obstet., November, 1914.
- Axhausen: Deutsche Ztschr. f. Chir., xci, 1907; Arch. f. klin. Chir., lxxxviii, 1908, lxxxviii, 1909, 23, xciv, 1911; and xcix, 1912, 1.
- Barnes: Surg., Gyn. and Obstet., October, 1914.
- Barth: Arch. f. klin. Chir., xlv, 1893, 409; Ziegler's Beiträge z. path. Anat., xvii, 1896.
- Baschkirzew and Petrow: Ztschr. f. Chir., cxiii, p. 490, 1912.
- Bier: Arch. f. klin. Chir., c, 1, 91, 1912.
- Brown and Brown: Surg., Gyn. and Obstet., 1913, xvii, 681.
- Buchmann: Zentralbl. f. Chir., 1908, 19.
- Cohn: Am. Jour. Surg., November, 1914.
- Cotton and Loder: Surg., Gyn. and Obstet., June, 1913.
- De Gouvea: La Presse Med., July 17, 1912.
- Eloesser: Cal. State Jour. of Med., December, 1913.
- Enderlen: Münch. med. Wochenschr., 1910, 35; Ztschr. f. ärztl. Fortbild., Jena, 1912, 737.
- Frangenheim: Arch. f. klin. Chir., 1910, xciii, 191.
- Galeazzi: Am. Jour. Orth. Surg., May, 1913, p. 662; Seventh Cong. of the Italian Orth. Soc., 1912.
- Gallie: Am. Jour. Orth. Surg., October, 1914.
- Goebel: Münch. med. Wochenschr., 1913, p. 356, and p. 1598.
- Goldmann: Münch. med. Wochenschr., 1910. No. 44.
- Hass: Surg., Gyn. and Obstet., August, 1913.
- Helferich: Münch. med. Wochenschr., 1911, p. 2796.
- Henderson: ANNALS OF SURGERY, April, 1914.
- Janeway: ANNALS OF SURGERY, August, 1910.
- Jokoi: Ztschr. f. Chir., cxviii, 433.
- Katzenstein: Berlin klin. Wochenschr., April 6, 1914, and April 13, 1914.
- Lexer: Arch. f. klin. Chir., lxxxvi, 1908; ANNALS OF SURGERY, August, 1914.
- McWilliams: ANNALS OF SURGERY, September, 1912, and April, 1914; Jour. A. M. A., January 31, 1914, p. 346.
- Macewen: "The Growth of Bone," Glasgow, 1912.
- Marchand: "Der Process der Wundheilung," Stuttgart, 1901.
- Mayer and Wehner: Arch. f. klin. Chir., 1914, p. 732; Am. Jour. Orth. Surg., October, 1914.
- Murphy: Jour. A. M. A., April 7, 1912, *et seq.*; Surg., Gyn. and Obstet., 1913, p. 493.
- Oechsner: Surg., Gyn. and Obstet., October 14, 1914.
- Ollier: Jour. de la Physiol., 1859; Mém. de la Soc. de Biol., 1859; Traité expérimental et clin. de la Regen. des Os, T. i and II, Paris, 1867.
- Petroff: Khirurg. Arkh. Velyaminova. S. Petersburg, 1911, p. 1034.
- Phemister: Surg., Gyn. and Obstet., September, 1914.
- Pockhammer: Arch. f. klin. Chir., 1911, xciv, 352.
- Putti: Arch. di ortopedia, An. xxx, F. ii, 1913, Soc. med. chir. di Bologna, 2 Mai, 1913; Am. Jour. Orth. Surg., April, 1914, p. 718.

## TRANSPLANTATION OF ENTIRE BONES

- Rhodes: Surg., Gyn. and Obstet., October, 1914.  
Roberts: Jour. A. M. A., November 16, 1912.  
Sievers: Beitrag. z. klin. Chir., Tübing, 1913, lxxxv, p. 1.  
Tomita: Virchow's Arch., exci.  
Trinci: Ztschr. f. orth. Chir., xxx, H. 1-2, p. 69, 1912.  
Walther: Bull. et Mém. de la Soc. de Paris, vol. 37, No. 20.  
Wieder: Univ. Penn. Med. Bull., 1907.  
Witherill: Jour. A. M. A., lx, No. 13, p. 983, and No. 20, p. 1533.  
Ziegler: Ztschr. f. Chir., lx, 1900.

# THE OSTEOGENIC POWER OF PERIOSTEUM: WITH A NOTE ON BONE TRANSPLANTATION

AN EXPERIMENTAL STUDY\*

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## INTRODUCTION

THE appearance of Macewen's monograph<sup>1</sup> caused considerable discussion among those interested in the growth of bone. His experiments seemed to show that periosteum was not a bone producing tissue, but that its function was simply that of a limiting membrane. This, of course, was not in accordance with the principles accepted for many years, and it was difficult to adjust ourselves to his ideas without first hand experimental proof.

The literature on this subject has been fully commented on in a number of recent experimental and clinical papers, so we will not consider it at this time. Suffice it to say that some investigators found osteogenic power in periosteum, and others did not.

We approached the subject with, as far as possible, unbiased minds, although if we had a leaning more one way than another, it was that periosteum was a bone producing tissue. In order to clear the matter up for our own satisfaction we have repeated during the last two years many of Macewen's experiments, and also have carried out a number of our own.<sup>2</sup>

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\* The full text of this paper was published in the Johns Hopkins Hospital Bulletin, March, 1915.

<sup>1</sup> "The Growth of Bone." William Macewen, F.R.S. (1912).

<sup>2</sup> In many of the original reports there is paucity of detail as to whether macroscopic particles of bone were adherent to and transplanted with the periosteum. We feel that definite conclusions as to the bone-producing power of periosteum can only be drawn from those experiments in which every effort was made to remove the periosteum without particles of the underlying bone. The character of the wound healing is also very lightly touched upon in many of these papers. It is also well to bear in mind that Ollier's classic work on bone and periosteum was done in the pre-antiseptic period of surgery.



## THE OSTEOGENIC POWER OF PERIOSTEUM

*Technic.*—The part was shaved or the hair was removed with a solution of sodium sulphide. The skin was washed with green soap and water, then with alcohol followed by ether. After the skin was thoroughly dry it was painted with tincture of iodine, 2.5 per cent. The iodine solution was also occasionally used in the open wounds, and after suture of the skin. Ether anæsthesia was used in each experiment. Fine black silk was the ligature and suture material used throughout. The wounds were closed in layers wherever possible. Collodion and gauze dressings were applied when necessary. Unless otherwise stated the healing will be understood as *per primam*. Landmark sutures were used when periosteum or bone was placed in the soft parts. The results were controlled by X-ray and microscopic examination.<sup>a</sup>

In these experiments, except where definitely specified to the contrary, care was taken not to remove any particles of bone with the periosteum. This was accomplished by outlining the periosteal flap down to the bone with a scalpel, and starting it away from the bone with a blunt instrument. Then by means of a small, very firm gauze pad, grasped in an artery clamp, the periosteum was removed without disturbing the surface of the bone.

Microscopic examination shows that the periosteum with the greater part of the *underlying osteoblasts* may be removed in this way.

For convenience in comparing the results we have divided the experiments into groups.

### GROUP I. THE TRANSPLANTATION OF FREE FLAPS OF PERIOSTEUM

A. THE TRANSPLANTATION OF FREE PERIOSTEUM WITHOUT BONE PARTICLES INTO THE MUSCLE OR SUBCUTANEOUS TISSUE OF THE SAME ANIMAL.—*Summary.*—Twenty-one experiments were done; 16 on dogs and 5 on young rabbits. The flaps of periosteum varied in size from that of the entire femur to an area 1 cm. wide from the circumference of the radius. In 1 experiment the periosteum from a section of fibula, 1.6 cm. long, was turned inside out in stripping it from the bone, thus exposing the surface next to the bone. In 6 experiments the periosteum was placed in the subcutaneous tissue, and in 15 in the muscle tissue. The periosteum was spread out and sutured in position in 7 experiments, and in 14 it was bunched. The specimens were examined 8, 14, 15, 19, 30, 31, 35, 78, 94, 95, 104, 113, and 133 days after opera-

<sup>a</sup> We take this opportunity of expressing our thanks to Dr. Harry F. Baetjer for the X-ray plates; and to Mr. C. R. Thomas for his aid in assisting us in carrying out the operative experiments.

tion, and in no instance could any growth of bone be detected, either by X-ray or by careful dissection.

B. THE TRANSPLANTATION OF FREE PERIOSTEUM WITHOUT BONE PARTICLES INTO THE MUSCLE OR SUBCUTANEOUS TISSUE OF ANOTHER ANIMAL OF THE SAME SPECIES.—*Summary*.—Five experiments were done on dogs. The periosteum was obtained from the circumference of a resected portion of the radius, varying in length between 2.2 and 3 cm. The transplants were placed in the subcutaneous tissue in 3 experiments, and in the muscle in 2. In each experiment the periosteum was bunched. The specimens were examined 27, 91, 121, 123, and 126 days after operation, and in no instance was any growth of bone detected, either by X-ray or by careful dissection.

C. THE INJECTION INTO THE SOFT PARTS OF SMALL BITS OF PERIOSTEUM WITHOUT BONE PARTICLES IN SUSPENSION.—*Summary*.—Six experiments were done on rabbits. The periosteum was obtained from the tibia in each instance. The flaps varied between 2 and 3 cm. long, by .5 cm. wide. The periosteum was cut into small bits with scissors, and was shaken up with from 10 to 15 minims of normal salt solution in 3 experiments, in Ringers' solution in 2 experiments, and in blood in 1 experiment. The injections were made into the subcutaneous tissue and muscle, 3 times each. The specimens were examined 10, 13, 29, and 32 days after injection. In 1 experiment, 32 days after injection of periosteum in salt solution, a single oblong bit of calcified tissue, 4 mm. by 2.5 mm., was found. There is doubt as to the origin of the fragment, as the injection was made subcutaneously in the lateral aspect of the middle of the thigh, while the calcified tissue was found close to the joint beneath the *rectus* muscle. Microscopic examination showed deep staining calcified material with no bone. In the other experiments no bone formation could be demonstrated, either by X-ray or by careful dissection.

These three groups of experiments show that neither free auto- nor isoperiosteum has the power of bone production when transplanted into soft parts, even though a considerable number of osteoblasts be adherent to the transplant.

D. THE TRANSPLANTATION OF FREE PERIOSTEUM WITH THIN BONE SHAVINGS ATTACHED, INTO SOFT PARTS OF THE SAME ANIMAL.—*Summary*.—Seven experiments were done on dogs. The periosteal flap with shavings of bone attached was obtained from the femur in each instance. It was either raised with a very thin chisel, or roughly with a curette. The flaps varied between 3 and 3.5 cm. in length, by 1 cm. to one-half the circumference of the femur in width. It was placed

## THE OSTEOGENIC POWER OF PERIOSTEUM

in the subcutaneous tissue 6 times, and in muscle tissue once. The specimens were examined 11, 64, 67, 127, and 128 days after operation. In each experiment there was definite bone formation. This bone growth was very much smaller than might have been expected from the size of the transplant with attached shavings. In no experiment was the new bone more than 4 mm. long by 1 mm. thick. In no instance was there more than a very slight roughening of the surface of the femur, from which the periosteum and bone shavings had been removed.

This group of experiments shows definitely that free periosteal flaps, with bone shavings attached, produce new bone. When compared with the results of transplantation of free periosteum without bone particles, it shows that bone particles and accompanying osteoblasts are necessary for the production of bone. It may be that this new bone would eventually have been absorbed, as the specimens contained a great deal less bone than was originally transplanted, in spite of the fact that so large a surface was exposed for the reception of a new blood supply.

E. THE TRANSPLANTATION OF FREE PERIOSTEUM WITHOUT BONE PARTICLES, CONGEALED IN A BLOOD CLOT, INTO THE SUBCUTANEOUS TISSUES OF THE SAME ANIMAL.—*Summary*.—Eight experiments were done on dogs. The periosteum was obtained from the shaft of the femur. The flaps varied between 2 and 4 cm. in length, by .75 cm. to one-half the circumference of the femur in width. In each experiment the periosteum was bunched and congealed in a blood clot, which was placed in the subcutaneous tissue. The specimens were examined 20, 87, 100, 112, and 113 days after operation. In 4 experiments, after 20, 87, 100 and 113 days, a well marked scar was found, with no evidence of bone formation, either by X-ray or by careful dissection. In 4 others, 100 and 112 days, a tiny calcified mass, scarcely 1 mm. in diameter, was found at the site of the transplant. In the 100-day specimen there had been a slight superficial infection of the skin wound, and although this was at some distance from the transplant, it may have had an influence on the deposit of lime salts. Microscopic examination showed definite new bone formation in both specimens, but it was much more marked in the one than in the other. In the 112-day experiments, on the other hand, the healing had been *per primam*, and the calcified material was smaller than in the 100-day experiments. Microscopic examination showed calcified material, but no definite bone tissue.

Calcification occurred in 4 of the 8 experiments. In 1 of these a small amount of bone was demonstrated microscopically. In another only a tiny particle of bone could be found, while in the 2 other ex-

periments showing calcification no bone could be found. It is well known that calcification in blood clots occasionally occurs, and it is possible that the presence of periosteum without bone particles in the blood clots may have influenced the deposit of lime salts. Taking into consideration the preceding experiments, it is probable that in the 2 experiments where bone was definitely demonstrated, some particles of bone had accidentally been transplanted with the periosteum.

#### GROUP II. THE TRANSPLANTATION OF PEDUNCULATED FLAPS OF PERIOSTEUM

A. THE TRANSPLANTATION OF PEDUNCULATED FLAPS OF PERIOSTEUM WITHOUT BONE PARTICLES INTO, OR AROUND, ADJACENT MUSCLE.—*Summary.*—Four experiments were done on dogs. The radius was utilized in each instance. The flaps were from 1 to 1.5 cm. wide, and from 3 to 4.5 cm. long. In 2 experiments the pedicle was left attached to the shaft of the bone, and in 2 to the epiphyseal line. In 1 of each the flap was drawn out into the adjacent muscle tissue, and in the others the free end was sutured to the cut edge of the radial periosteum. The specimens were examined 151, 212, 216, and 220 days after operation. In none of these experiments could any bone formation be demonstrated, either by X-ray or by careful dissection. In 2 experiments the surface from which the periosteum was raised was scarified, and in each of these there was slight roughening of the bone at the point of scarification. This also occurred in 1 experiment where the bone was not scarified, while in the other the bone was perfectly smooth. The roughening could be felt rather than seen. It was easy to demonstrate the area from which the flap was raised, as the line of incision was outlined at the time of operation with sterile India ink, and enough remained to definitely show the location.

These experiments show that there is no bone formation from periosteum, even though the periosteal flap is still attached by a pedicle to the bone itself.

B. THE TRANSPLANTATION OF PEDUNCULATED FLAPS OF PERIOSTEUM, WITH A THIN FILM OF BONE ATTACHED, INTO ADJACENT SOFT PARTS.—*Summary.*—Eight experiments were done on dogs; four on the ribs and 4 on the femur. The specimens were examined 23, 34, 50 and 171 days after operation. The flaps on the femur varied from 2 to 3 cm. long, by .8 to 1 cm. wide; on the ribs from 1 to 3 cm. long, by the width of the rib. On the femur the muscles were sutured beneath



## THE OSTEOGENIC POWER OF PERIOSTEUM

the flap, and on the ribs the adjacent soft parts. In 2 experiments the flap was accidentally detached from the rib; but its attachment was placed in contact with the denuded bone and secured. In each experiment the bone-periosteal flap lived and new bone formed from it. The intermediate cartilage stage was noted in the femur flaps, but not in the rib flaps.

These experiments show that pedunculated flaps of periosteum with a thin bone film will live and produce new bone, and become greatly thickened. This thickening was considerably reduced in the 171-day experiment, as might be expected. These experiments are of some clinical interest, as this is undoubtedly what happens when a strip of periosteum with bone, still attached to the bone at one end, is raised by trauma, and accidentally implanted in adjacent soft parts. The contrast between this group and the pedunculated flaps of periosteum in soft parts without bone particles attached, is very significant, and further strengthens the conclusion that the presence of bone on periosteum is necessary for the production of bone (Fig. 1).

*Remarks.*—From the results of Groups I and II, we find that free periosteum without bone particles adherent to it will not produce new bone when transplanted into muscle or subcutaneous tissue of the same animal. That this is also true for iso-transplants of periosteum alone. That new bone was found in 2 experiments, and calcification in 2, in which the free periosteum had been congealed in a blood clot before transplantation. In the 2 experiments in which bone was found, it is possible that small bits of bone were accidentally transplanted with the periosteum. That free periosteal flaps with thin bone shavings attached did produce bone in each experiment. That pedunculated flaps of periosteum without bone did not produce bone in a single instance. That pedunculated flaps of periosteum with a thin film of bone did produce bone in every instance.

The clinical use of the free transplantation of periosteum is of value only in those instances where periosteum has been employed to fill in defects. In such operations the result depends entirely on the formation of bone, and bone will not be formed unless bone is transplanted with the periosteum. The chances are that even the new formed bone will eventually be absorbed. The pedunculated periosteal flap with a thin film of bone attached is of considerable interest, as it may help to explain some of the remarkable post-traumatic X-ray plates which are sometimes difficult to interpret.

The nourishment of the bones was in no way affected by stripping



off the periosteum, unless the nutrient artery was interfered with. In those instances in which the artery was cut, the bone was apparently normal, but the X-ray showed changes in its nutrition. In very few instances was the bone from which the periosteum was stripped visibly thickened, unless it had been considerably traumatized. In some instances, in spite of chiselling and scraping, there was practically no overgrowth of new bone.

The defects in the periosteum were, in many instances, replaced by a fibrous membrane, which resembled the periosteum in appearance, but was much more tightly adherent to the bone than was the normal periosteum. In some instances the muscle tissue was tightly adherent to the bone.

GROUP III. THE SUBPERIOSTEAL RESECTION OF BONE, LEAVING THE PERIOSTEAL TUBE, AS FAR AS POSSIBLE, UNDISTURBED

*Summary.*—Eleven experiments were done on dogs. In 8 experiments, sections of rib were removed, and in 3, sections of the radius. The length of the pieces of rib removed varied between 1.5 and 3 cm. The length of the sections of radius varied between the entire radius with articulating surfaces and 2.5 cm. of the shaft. Metal caps were placed on the bone stumps under the periosteum in 3 experiments. The specimens were examined 14, 28, 31, 87, 100, 105, 106, 129, 141, 143, and 146 days after operation. In 4 of the experiments the periosteal tube was closed separately. In 7 the periosteal tube was drawn together by closure of the overlying soft parts (Fig. 2).

*Remarks.*—This group shows that the periosteum acts only as a limiting membrane. In those experiments without metal caps where the periosteal tube was closed separately, the size of the new-formed bone was almost normal. In those where the periosteal tube was not closed the bone was somewhat irregular in shape. In none of the experiments could it be definitely demonstrated that the new bone was produced from the periosteum. The only instance where new bone occurred along the periosteal tube was in the resection of a portion of the radius, in which experiment no particular attention was given to the removal of bone particles from the line of muscle attachment. Even in this experiment the growth of bone was much more marked at the radial stumps. In the metal cap experiments the growth of bone was definitely from the shaft of the bone behind the caps, rather than from the periosteum (Fig. 3).



FIG. 1.—A pedunculated flap of periosteum with a thin film of bone was raised from the femur and also from a rib. The soft parts were sutured beneath them. Photographs and X-ray taken 50 days later. The bone was accidentally broken away from the femur before X-ray was taken.

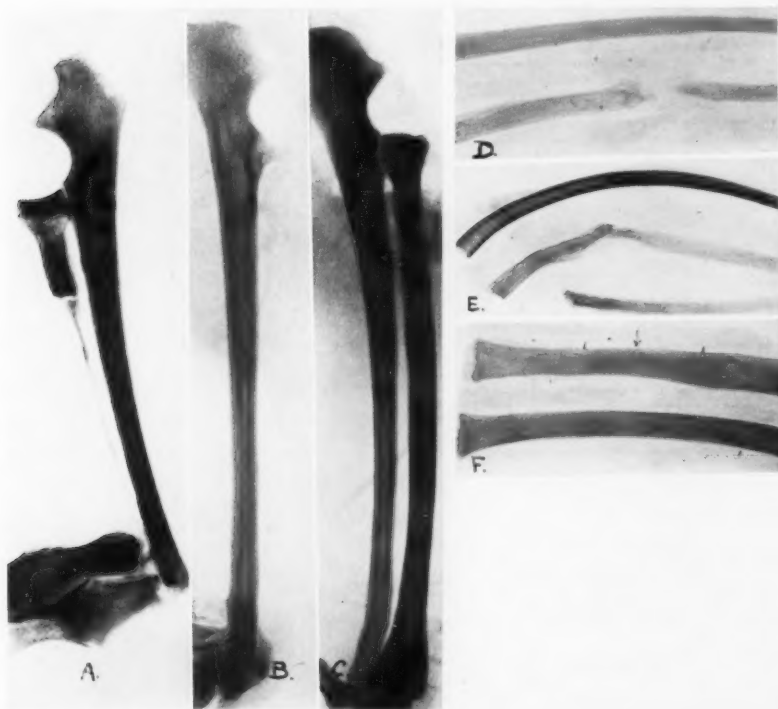
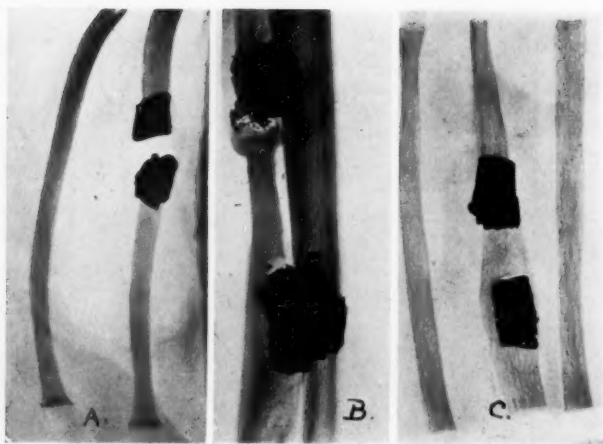


FIG. 2.—A. A section of radius 5.8 cm. long was excised subperiosteally. No attempt was made to remove the tiny particles of bone, which may have adhered to the line of muscle attachment. X-ray taken 31 days later. Note new bone along line of bone particles. B. The entire radius, including the articulating surfaces, was removed subperiosteally. No visible bone particles were allowed to remain. X-ray taken 129 days later. No new bone formation could be made out. C. Control. D. Extent of regeneration of a rib after a partial subperiosteal resection of 2.8 cm. X-ray taken 87 days later. The growth is only from the rib ends. E. Extent of regeneration of a rib after partial subperiosteal resection of 2.1 cm. X-ray taken 105 days later. The irregular growth is from the rib ends. The periosteal tube was not closed in either D or E. F. The regeneration of a rib after partial subperiosteal resection of 3 cm. X-ray taken 100 days later. The periosteal tube was closed and the growth from the rib ends has followed the tube.



■ FIG. 3.—A. Metal caps placed on stumps, after subperiosteal resection of 1.5 cm. of a rib. The tube between the caps was dry. The periosteum was closed over the caps. X-ray taken 28 days later. B. Metal caps placed on stumps after subperiosteal resection of 2.5 cm. of the shaft of the radius. The tube between the caps was dry. The periosteum was not closed. X-ray taken 106 days later. C. Metal caps on the stumps after subperiosteal resection of 2 cm. of a rib. A blood clot was placed in the tube between the caps, and the periosteum was closed. X-ray taken 141 days later. In A there was no attempt at bone formation from the periosteum. In B the new bone was formed from the side of the shaft, back of the lower cap. In C the same thing has occurred, although the X-ray from above does not demonstrate it.

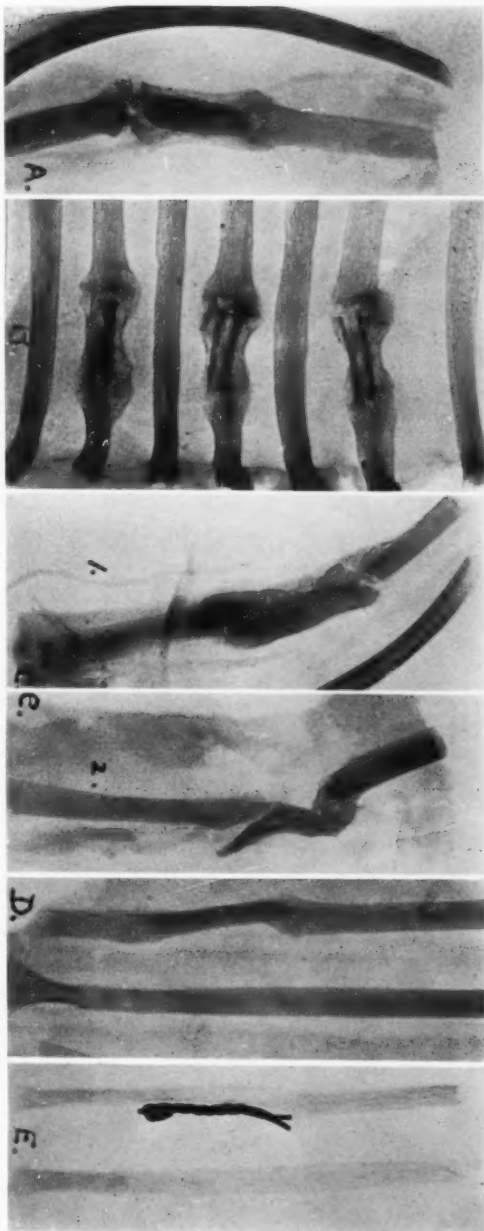


FIG. 4.—A. Auto-skull bone without periosteum, in defect left by subperiosteal resection of 2 cm. of a rib. The periosteum was closed. X-ray taken 35 days later. B. Sections of iso-rib without periosteum, in defects left by subperiosteal resection of portions of 3 ribs. The periosteum was closed over each. X-ray taken 44 days later. C. Auto-bone shavings with blood in defect after subperiosteal resection of a rib. The periosteum was not closed in either experiment. X-ray taken (1) after 50 days; (2) after 94 days. D. Auto-fibula with its periosteum in the defect after subperiosteal resection of 2 cm. of a rib. The periosteum was closed over the transplant. X-ray taken 93 days later. E. A piece of twisted silver wire was placed in the defect made by the subperiosteal resection of 2.4 cm. of a rib. The periosteum was closed over the wire. X-ray taken 200 days later.

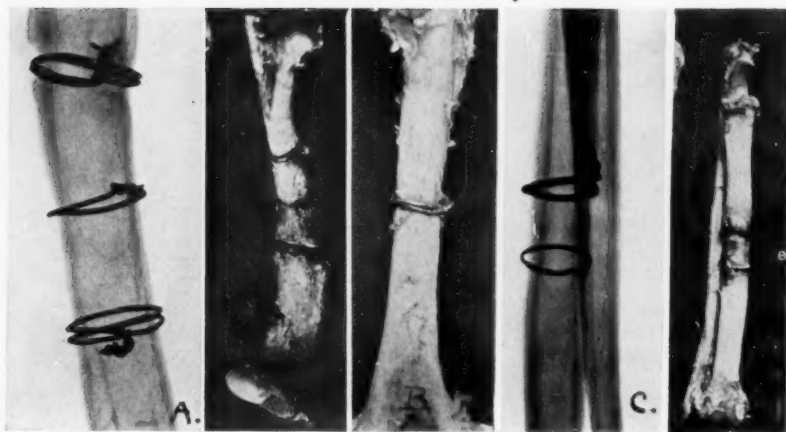


FIG. 5.—Silver wire experiments on dogs. A. The upper wire was placed over intact periosteum; the middle wire was placed over a cuff of fascia lata, after removal of the periosteum, the lower wire was placed on the bone after removal of a zone of periosteum. X-ray taken 66 days later. B. Wire around denuded bone after 91 days. C. The upper wire was placed over intact periosteum; the lower wire was placed around the bone subperiosteally. X-ray taken 167 days later.

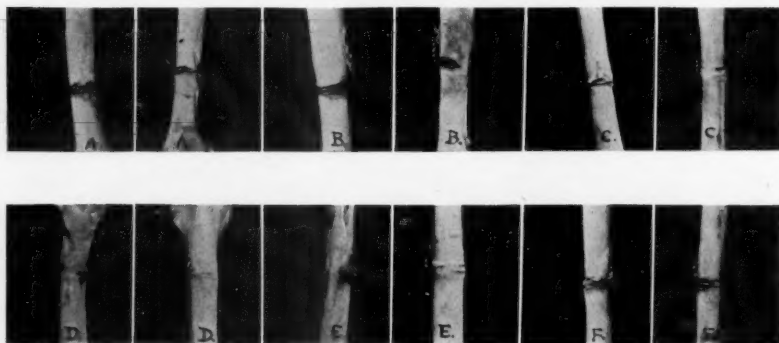


FIG. 6.—Silver wire experiments on rabbits. Front and back views. Silver wire was snugly wrapped around the shaft of the femur, after removal of zones of periosteum from 1.5 to 4 cm. wide. A. After 44 days. B. After 48 days. C. After 54 days. D. After 121 days. E. After 122 days. F. After 122 days. In A and D no precautions were taken against infection. In E the bone was curetted before the wire was applied.



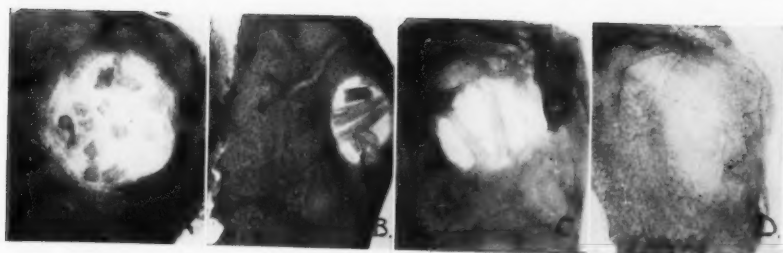


Fig. 7.—Split auto-rib in skull defects. A. After 35 days. The defect is entirely filled with rigid bone. B. After 49 days. C. After 89 days. D. After 105 days.

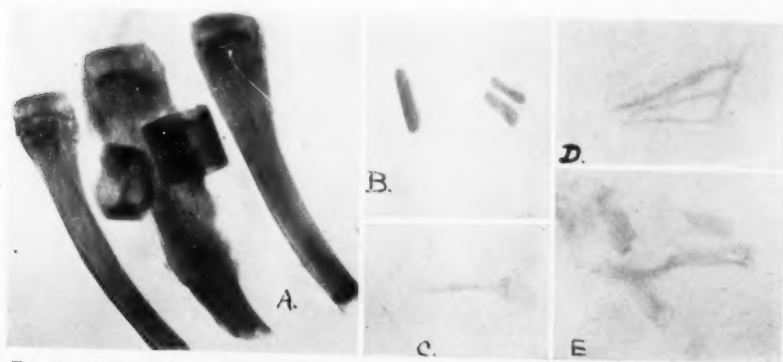


FIG. 8.—A. Sections of auto-radius, each .75 cm. long, were placed on a denuded rib. 1, was covered with periosteum; 2, was without periosteum. The wound became infected. The transplant with periosteum is still clear cut, and has resisted absorption much better than the transplant without periosteum. Note the stimulation of new bone due to infection along the denuded rib. B. A section of auto-fibula, 3 cm. long, was excised, and the periosteum was stripped back from each end. One centimetre of denuded bone was cut off from each end. The periosteum was then drawn over the ends of the undisturbed portion, and twisted, the transplant being thus entirely covered with periosteum. The 3 pieces were then buried in muscle. 1, the specimen covered with periosteum was rigid and intact, except for absorption at the ends; 2, the two pieces without periosteum were shortened and flexible, and showed evidences of absorption. X-ray taken 128 days later. C. An intact auto-phalangeal bone, after 108 days in the soft parts. There are definite evidences of absorption. D. A section of auto-rib, 2.4 cm. long without periosteum, was split into 4 pieces and placed side by side in the soft parts. X-ray taken 100 days later. E. Two sections of auto-rib without periosteum, each 1.8 cm. long, were placed side by side in the soft parts. X-ray taken after 127 days.



## THE OSTEOGENIC POWER OF PERIOSTEUM

### GROUP IV. THE TRANSPLANTATION OF BONE AND OTHER SUBSTANCES INTO THE PERIOSTEAL TUBE AFTER PARTIAL SUBPERIOSTEAL RESECTION OF A RIB

*Summary.*—Twenty-one experiments were done on dogs. The length of the sections of rib removed varied between 1.5 and 3 cm. The periosteum was closed over the transplant in 18 experiments, and the transplant was held in the periosteal trough by sutures in 3 experiments. Autobone with periosteum, and without periosteum, was used in 3 each. Isobone without periosteum was used in 10. Autocartilaginous rib with perichondrium, an intact phalangeal bone, cowhorn, dried isotendon, silver wire, and insoluble gelatin, were used in 1 each. The specimens were examined 24, 30, 31, 35, 44, 50, 92, 94, 100, 105, 107, 146, 206, and 215 days after operation (Fig. 4).

*Remarks.*—In each experiment in which the transplant was covered with either periosteum or perichondrium, the growth of bone wherever present originated from the rib ends and not from the periosteum. The periosteum and cartilage of the intact phalangeal transplant prevented the entrance of any new bone from the rib ends, and the transplant was pushed to one side by the bone growth from the rib ends, as an impervious foreign body would have been. The periosteal covering of the other transplants allowed the growth of bone to enter the transplant only from the ends. In those instances where there was growth over the surface of the transplant, it ran between the periosteal tube of the rib and the periosteal covering of the transplant. In those experiments in which the transplant was without periosteum we found that both auto- and isobone caused very marked stimulation of bone growth, both from the rib ends and from the periosteum, in a comparatively short period of time. The stimulation of bone growth was much more marked than in the experiments where periosteum was left on the transplant. It was noted that transplants of the same size under exactly the same conditions acted quite differently; some apparently causing more stimulation than others. Some acted as a foreign body; some were undergoing absorption; some had disappeared, while others were incorporated in the continuity of the bone. In no instance could new bone formation be demonstrated from the grafts.

The cowhorn and dried isotendon had been absorbed, and the continuity of the ribs restored. It was impossible to say whether the new bone formation was from the rib ends or from the periosteum. In the experiment with the gelatin roll, the continuity of the rib was not

restored, even after 215 days. The gelatin was still present, and there was growth of bone from both rib stumps, extending a short distance into it. There had been no periosteal bone formation.

In the experiment with twisted silver wire the rib had regenerated, and the wire was pushed to one side by the bone formation which had gone on beneath it from the rib ends. Had the growth of bone been from the periosteum the wire might have been surrounded by bone. Transplants covered with periosteum, and also foreign bodies, seem to have no effect on the periosteum, but in each experiment there was stimulation of growth from the rib ends.

#### GROUP V. SILVER WIRE EXPERIMENTS

*Summary.*—Fourteen experiments were done on 8 dogs, and on 6 rabbits. The femur was used in 6 experiments, the humerus in 5, and the radius in 3. In 7 experiments the silver wire was wrapped snugly around the bone after removal of the periosteum. The bone was curetted in 1 experiment; no precautions were taken against infection in 2, and in 1 of these the bone was also scraped. In 2 experiments the wire was placed over intact periosteum; in 1 over a fascia cuff, after removal of the periosteum; and in 1 subperiosteally. The zone of periosteum removed varied in width between 1 and 3 cm.

*Remarks.*—There was no visible thickening of the area from which the periosteum was stripped in the dog experiments, but there was definite thickening over this area in each instance in the experiments on rabbits (Fig. 5). In fact there seemed to be a somewhat greater tendency to bone growth in the rabbits in this group of experiments than in the dogs (Fig. 6).

One is struck by the fact that the most extensive growth of new bone around the wire occurred in the experiments where no precautions were taken against infection, and also where the bone was curetted after removing the periosteum. The thickest growth was always posteriorly, in the region from which the muscle attachment was torn, or, in other words, where the bone was most traumatized.

From these experiments we are led to believe that there is little if any new bone formed from the surface of a bone after removal of the periosteum, unless the bone surface itself is irritated, either mechanically or by infection. That absorption occurs when silver wire is snugly applied around bone over intact periosteum, and also at times when around denuded bone. That there is little if any new bone formation from the periosteum or bone when a silver wire is placed

## THE OSTEOGENIC POWER OF PERIOSTEUM

around a bone subperiosteally. Thus it would seem that in those experiments reported by others in which the ring was completely buried in new bone either there was infection or the surface of the bone was much traumatized after or during the removal of the periosteum.

Clinically, I have noted when bones had been sutured with silver wire that there was usually absorption beneath the wire, rather than new bone formation over it.

### GROUP VI. THE IMPLANTATION OF BONE AND ALSO PERIOSTEUM INTO PREPARED DEFECTS IN THE SKULL

*Summary.*—Nine experiments were done on dogs. In 2 experiments autoperiosteum was transplanted; in 4, auto split rib without periosteum; in 1, auto rib cut into bits; in 2, iso split rib was used. In 1 experiment the defect was made with a trephine, and in 8 with the Hudson burr. The diameter of the defects varied between 1.1 to 2 cm. The transplants were placed on the dura in each instance. The specimens were examined 35, 49, 93, 105, and 146 days after operation.

*Remarks.*—These experiments show that transplants without periosteum retained their vitality, and that there was proliferation of bone from them, as well as from the edges of the defects. This was especially noticeable in the small fragments, as there was comparatively a much larger raw surface and consequently better blood supply. The new bone seemed to come from the cut surfaces, rather than from the surface from which the periosteum was stripped. In 1 experiment there was new bone found in a periosteal strip which had been scraped from a rib (thus making bone particles possible), but, in another experiment, where there was positively no bone attached to the periosteum, no new bone was formed. In 2 experiments where isografts without periosteum were transplanted the outlines of the grafts were still present after 105 and 146 days. The transplants had been replaced by new bone from the edges following the line of the grafts. The stimulation of the edges of the defect seemed as great where isobone was transplanted as when autotransplants were used, also the closure of the defect was equally as good in each (Fig. 7).

### GROUP VII. AUTOBONE IN SOFT PARTS

*Summary.*—Twenty-five experiments were done on dogs. In 8 the bone was transplanted with its periosteum; in 17 without periosteum. In 11, sections of the ribs were used; in 4, portions of the radius; in 7, sections of the fibula; in 2, bone shavings from the skull; and in 1,



an intact phalangeal bone. The bone fragments varied in length between .5 and 3 cm. The specimens were examined 11, 14, 19, 20, 55, 67, 94, 100, 104, 108, 113, 127, 128, 141, 143, 147, 206, and 207 days after operation.

*Remarks.*—It is a difficult matter to draw conclusions from this group of experiments, as in some instances the findings seem to contradict each other. Those experiments where the bone was transplanted without periosteum present very different pictures. Beginning absorption was noted as early as 19 days. A section of rib 2 cm. long had disappeared in 104 days. Then, on the other hand, portions of almost transparent bone were still present after 113, 128, 141, 143 and 207 days, while transplants of the same size in the same animals were absorbed in the same length of time. The rib transplants became flexible. In 3 experiments the transplants were placed close together. In 2 of these where sections of the whole rib (in the subcutaneous tissue, and split rib in muscle) were used, there was definite new growth of bone and growing together of the fragments, but at the same time there were marked absorptive processes going on, and the resulting mass was paper thin and almost transparent. When 2 pieces of the fibula were placed side by side in muscle, no such growth was noted.

Those experiments where the bone was transplanted with its periosteum seem to show that the periosteum has a certain protective action on the transplant. Sections of fibula without periosteum had markedly softened and reduced in size, after 128 days, while a control section of fibula covered with periosteum was practically intact in the same length of time. A section of rib with a strip of periosteum had been absorbed in 108 days, while an intact phalangeal bone was still present after the same length of time, although reduced in size.

In practically all of the transplants which remained at time of examination there were signs of absorption, which were more or less marked. In only 2 of the entire group was there any attempt at new bone formation, and even in these marked absorption was also going on. The periosteal covered transplants seemed to be somewhat more resistant to absorption than those without periosteum. There was little difference in result, whether the transplants were placed in muscle or in subcutaneous tissue.

The blood supply probably has a good deal to do with the length of time a transplant can remain in soft parts without absorption. The type of bone used may also have some bearing on this point, a porous bone being easier to nourish than solid bone. If this was an important

## THE OSTEOGENIC POWER OF PERIOSTEUM

point it would seem likely that the bone shavings with blood would have survived better than the solid pieces.

From the above experiments we feel justified in saying, that in the large majority of cases absorption takes place when a transplant of auto-bone, either with or without its periosteum, is placed in soft parts. We cannot say what would be the fate of those transplants which have grown together and produced new bone, but as absorption was also going on in the bone, and as the tendency of free bone in soft parts is to be absorbed, it seems logical that absorption would eventually have taken place (Fig. 8).

### GROUP VIII. ISOBONE IN SOFT PARTS

*Summary.*—Nine experiments were done. In 3 the bone was transplanted with its periosteum, and in 6 without the periosteum. In 4 the radius was used, the rib and the skull in 2 each, and the fibula in 1. The longest bone fragment was 2.4 cm., and in 1 instance bone shavings were transplanted. The specimens were examined 11, 13, 33, 74, 93, 100, 145, 147, and 151 days after operation. The transplants were placed in the subcutaneous tissue in 5 instances, in the muscle in 3, and in the abdominal cavity in 1 instance.

*Remarks.*—It is again difficult to draw definite conclusions in this group, except that absorption takes place, which would probably eventually lead to complete disappearance of even those transplants in fairly good condition.

A cross-section of the radius, with periosteum, showed beginning absorption from the ends when examined 33 days later; another section of the radius, with periosteum, was in a good state of preservation 151 days after transplantation, except that considerable absorption had taken place from the ends. The periosteum seemed to have some power of preventing absorption when it remained attached to the bone. On the other hand, a piece of split radius, without periosteum, was still present after 145 days, although absorption was progressing. In no instance was there any attempt at new bone formation from the transplants.

### GROUP IX. AUTOBONE IN BONE DEFECTS

*Summary.*—Eight experiments were done on dogs. Defects were prepared in the radius in 2, the fibula in 4, and in the humerus and femur in 1 each. The periosteum was removed with the bone in each experiment. The resected bone varied between 1.4 and 4 cm. in length. The transplants were from the rib in 3, from the fibula and radius

## DAVIS AND HUNNICUTT

in 2 each, and from the femur in 1. They were without periosteum in 5, and with periosteum in 3. The specimens were examined 16, 64, 87, 92, 113, 130, 144, and 152 days after operation.

*Remarks.*—These experiments show that autobone, both with and without periosteum, may be successfully transplanted to fill defects in bone. Tiny bits may be used, or one single piece. The transplant tends to assume the size of the bone into which it is transplanted.

### GROUP X. ISOBONE IN BONE DEFECTS

*Summary.*—Seven experiments were done on dogs. The defects were prepared in the radius in 6, and in the fibula in 1. The periosteum was removed with the bone in each experiment. The resected bone varied between 1.8 and 3 cm. The transplants were obtained from the radius in 5, and from the rib and fibula in 1 each. In 2 experiments the transplants were covered with periosteum. The specimens were examined 20, 27, 29, 74, 121, 123, and 126 days after operation.

*Remarks.*—This group leads us to believe that isobone in a bone defect stimulates the growth of bone from the bone stumps. That the bone acts as a sort of scaffold to the growth of new bone, from the living bone stumps. That there is shortening of the bone into which the transplant is placed, and that there is ultimate absorption of the transplant.

### CONCLUSIONS

Free periosteal transplants did not produce bone in the large majority of experiments, even though osteoblasts were adherent to the transplants.

Pedunculated flaps of periosteum did not produce new bone.

Free periosteal transplants and pedunculated periosteal flaps with bone shavings attached produced bone in each experiment. From this we might surmise that bone particles had been accidentally transplanted in those experiments in which bone was found after the transplantation of free periosteum.

The removal of periosteum had little, if any, effect on the nutrition of a bone. The surface from which the periosteum was removed showed very little overgrowth of bone, unless there had been considerable irritation of that surface, either by trauma or by infection. The area from which the periosteum was taken was covered by a thin, very adherent fibrous membrane, or the muscle tissue was adherent to the denuded area.

## THE OSTEOGENIC POWER OF PERIOSTEUM

Absorption occurred when a silver ring was snugly applied around a bone over the periosteum, and also at times when it was applied around denuded bone. There was no new bone formed from either the periosteum or bone when a silver ring was placed around a bone beneath the periosteum.

Both auto- and isobone, without periosteum, were effective in repairing skull defects.

Auto- and isobone, without periosteum, when transplanted into the periosteal tube after subperiosteal resection of a rib, caused stimulation of bone growth from the periosteum, and also from the rib ends.

Transplants covered with periosteum, and foreign bodies, stimulated bone growth only from the rib ends.

Transplants of the same size in a periosteal tube, after subperiosteal resection, under exactly the same conditions, acted quite differently.

After subperiosteal resection of a portion of a bone, the growth of bone in repairing the defect was from the bone stumps, the periosteum acting as a limiting membrane.

Autobone, both with and without periosteum, lived and was successfully transplanted to fill defects in bone. Clinically, it is advisable to transplant bone covered in part, at least, with periosteum.

Isobone in a bone defect acted as a scaffold for the growth of new bone from the living bone stumps, but there was ultimate absorption of the transplant.

Autobone, both with and without periosteum, was absorbed when transplanted into soft parts.

The periosteum seemed to have some protective influence against early absorption.

The fate of those transplants which had grown together and produced new bone is doubtful, but as absorption was going on, and as the tendency of free bone in the soft parts is to be absorbed, it seems probable that absorption would eventually occur.

The same may be said of isobone in soft parts, except that in no instance was any new bone formed from the transplant.

The growth of new bone from bone stumps after resection of a portion of a bone with its periosteum is astonishingly slow, being very little more advanced after 6 months than after 6 weeks.



## GUNSHOT INJURIES OF THE SPINAL CORD

A PRELIMINARY REPORT UPON FIVE CASES

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THE following cases of gunshot injuries of the spinal cord were observed at the Hospital of the American Ambulance in Paris during the autumn of 1914.

CASE I.—J. G., aged twenty-three. On September 22 at 6 A.M., the patient was standing in an open field, clad in uniform and great coat. He heard a rifle report and at once felt a sharp, cold sensation in his legs. He fell upon his face and was not able to move his legs or arms. After ten hours he was removed from the field. He became incontinent of urine and feces. He was catheterized for the first time, four days after his injury.

On September 27 he was admitted to the American Ambulance in Paris.

On October 2 slight power of sensation was noted over the left leg. Complete motor paralysis of both lower extremities.

On October 14 slight sensation was elicited over the outer aspect of the left thigh to the knee, otherwise there was complete sensory paralysis of both lower extremities up to the level of the anterior superior spines of the ilia. Very slight power of contraction of left psoas muscle, otherwise complete motor paralysis of both lower extremities. Flaccid paralysis of bladder. Paralysis of anal sphincter and rectum. Reddening of skin over lower sacrum, otherwise no trophic disturbances.

There is a small circular healed wound of entrance in the left flank, 5 cm. from the vertebral column, and on the level of the twelfth dorsal vertebra.

The X-ray (Figs. 1 and 2) shows a rifle bullet at the lower level of the twelfth dorsal vertebra, lying directly in the spinal canal, with its base against the anterior wall of the canal, its point directed backward and slightly downward and to the left. Apparently the bullet was deflected, by the body of the twelfth dorsal vertebra, more than a right angle from its original course.

*Operation* (October 16).—Under ether anæsthesia, an incision 10 cm. in length was made between the tenth dorsal and fourth lumbar vertebræ, just to the left of the midline of the back, and carried in depth to the deep lumbar fascia. This fascia was then divided in the same line, and the erector and multifidus spinæ



## GUNSHOT INJURIES OF THE SPINAL CORD

muscles freed from the spinous processes and laminæ of the included vertebræ on the left side of the spine, and retracted laterally. The point of the bullet was readily discovered between the laminæ of the twelfth dorsal and first lumbar vertebræ, and the extraction of the bullet by means of a dressing forceps was a simple matter. The space occupied by the bullet led down to the right side of the dura, where compression of the cord must necessarily have existed. The dura appeared to be intact, so no further exploration was attempted. Several small fragments of loose bone from the lamina of the twelfth dorsal vertebra were extracted. The muscles were allowed to fall back into place and sutured to the periosteum of the spinous processes with interrupted chromic gut, a gauze drain being inserted down to bone in the middle of the wound. The fascia was closed in a similar manner, the skin with interrupted silkworm-gut.

October 17: Skin over lower sacrum, 5 cm. in diameter, broken down. Gauze drain removed from wound.

*Subsequent Course.*—The wound healed by primary union. During the first week after operation, there was a slight return of sensation in both thighs down to the knees. There was also a slight return of muscular power in the flexors of the hip-joint, more especially on the right side, so that the patient could raise his right knee from the bed. From that time on the improvement was very gradual. The last examination made by Dr. Craig on November 15, a month after operation, showed a complete flaccid paralysis of both legs, neither flexion nor extension of the feet being possible. The calves are atrophic. The thighs are weak, but when the legs are passively extended or flexed they can be moved weakly in the opposite direction. The power of the adductors is very good. Reflexes in knees and ankles absent. No plantar response. Sense of position lost in right ankle and toes of both feet, but preserved in left ankle. There is a slight return of sensation in both bladder and rectum, but no return of control. The sacral bed-sore has not extended, but remains unhealed.

CASE II.—J. A., aged thirty-one. On October 6 at 3 P.M., near Arras, the patient was lying face downward in a field, clad in his uniform and great coat. He suddenly felt a sharp stinging sensation in the back, but heard no sound. He immediately lost all sensation in his lower extremities, and was unable to move them. He lay there until 9 P.M. when he was moved to the rear. He was catheterized that night.

On October 15 he was admitted to the American Ambulance in Paris.

On October 16 examination showed marked œdema and ecchy-

mosis of the skin of the back. No point of tenderness or deformity made out along the spine. There was a small circular wound of entry posterior to the angle of the left scapula. Complete motor and sensory paralysis below the waist, with an absence of reflexes. Fecal incontinence and a greatly distended bladder, containing thirty-two ounces of urine.

On October 17 examination elicited very slight sensation along the outer aspect of the right thigh to the knee, and along the lower half of the inner aspect of the same thigh.

The X-ray (Fig. 3) showed a bullet with its base imbedded in the intervertebral disc between the first and second lumbar vertebræ, and its point directed upward and backward and to the right. The bullet had evidently crossed the canal from left to right, and had been deflected more than a right angle in two planes of its course. An exploration of its course was deemed advisable.

*Operation* (October 18).—Under chloroform and ether anæsthesia, an incision 15 cm. in length was made between the tenth dorsal and fifth lumbar vertebræ, just to the left of the midline of the back, and carried in depth through the deep lumbar fascia. The muscles on the left side of the spine were stripped from their attachments to the spinous and transverse processes along the whole length of the incision, and retracted laterally. The left transverse process of the twelfth dorsal vertebra was found to be fractured, as well as the body of the first lumbar vertebra. On following the bullet sinus from this point downward and to the right, the dura was found to be in shreds, and the cord divided except for a few nerve filaments. Several small bone fragments were removed from the spinal canal. The bullet had apparently passed from this point in a downward direction, and from left to right, through the posterior portions of the bodies of the first and second lumbar vertebræ. No effort was made to find the bullet. The muscle and fascia were closed with interrupted plain gut sutures, a gauze drain being introduced down to the bullet sinus. The skin was closed with interrupted silkworm-gut.

*Subsequent Course*.—Four hours after operation the patient's condition became very bad, and during the night he developed œdema of the lungs. Under forced stimulation his condition improved, and in twenty-four hours' time it became satisfactory. The wound became infected with the bacillus pyocyaneus, which yielded to treatment. He developed a large sacral bed-sore, and one over each trochanter. He also developed a cystitis, which improved under treatment.

An examination on November 8, three weeks after operation, showed a complete flaccid paralysis of both lower extremities, with an atrophy of all the muscle groups of the legs, thighs and



FIG. 1.—Case I. Lateral view. Rifle bullet penetrating spinal canal between the spines of the twelfth dorsal and the first lumbar vertebrae.

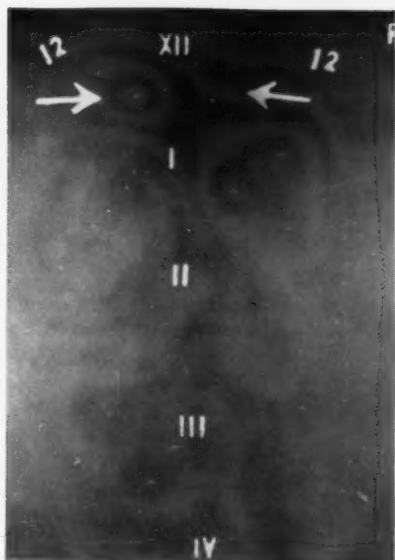


FIG. 2.—Case I (see Fig. 1). Anteroposterior view. Rifle bullet in spinal canal.

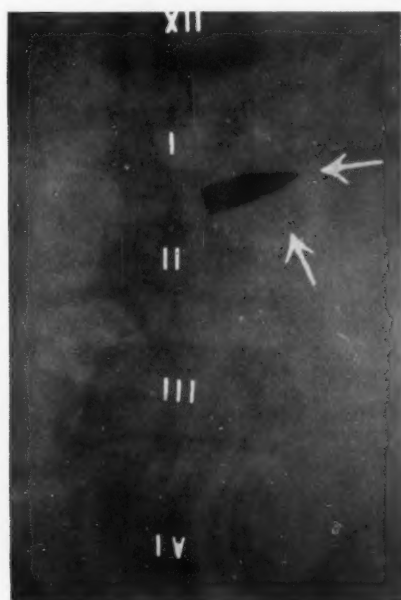


FIG. 3.—Case II. Rifle bullet in intervertebral disc between first and second lumbar vertebrae.

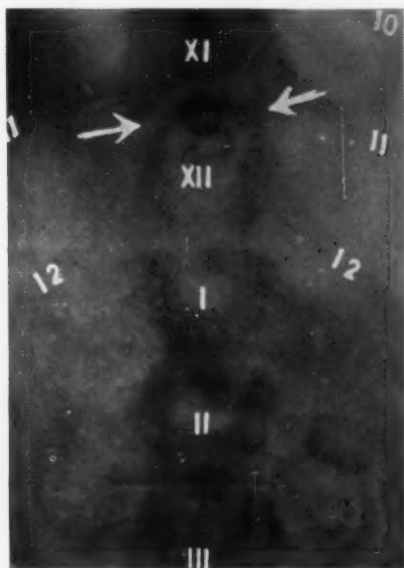


FIG. 4.—Case III. Anteroposterior view. Shrapnel ball in spinal canal between eleventh and twelfth dorsal vertebrae.

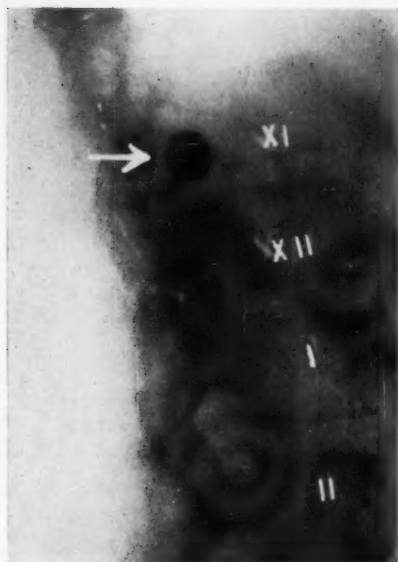


FIG. 5.—Case III. Lateral view. Shrapnel ball in spinal canal between eleventh and twelfth dorsal vertebrae.

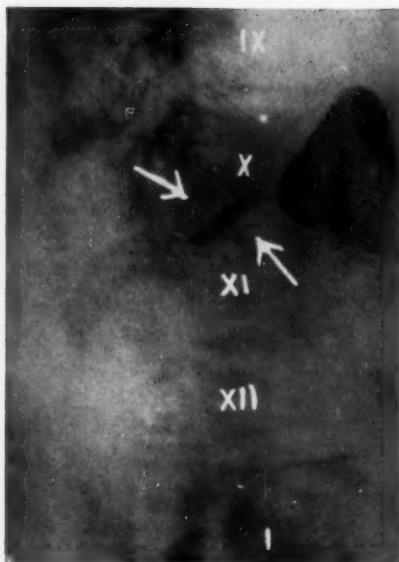


FIG. 6.—Case IV. Lateral view. Metal rivet imbedded in intervertebral disc between tenth and eleventh dorsal vertebrae.

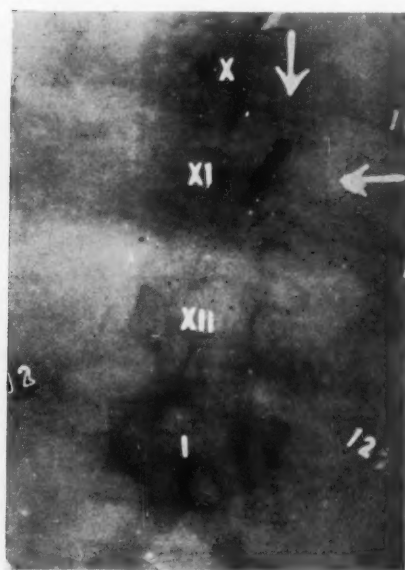


FIG. 7.—Case IV. Anteroposterior view. Metal rivet imbedded in intervertebral disc between the tenth and eleventh dorsal vertebrae.

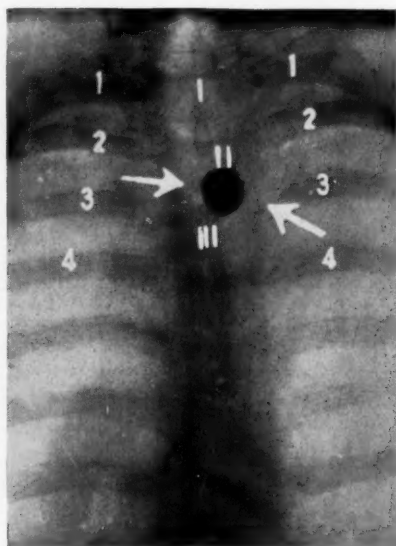


FIG. 8.—Case V. Anteroposterior view. Shrapnel ball in spinal canal at level of intervertebral disc between second and third dorsal vertebrae.

## GUNSHOT INJURIES OF THE SPINAL CORD

buttocks. He has irregular attacks of lancinating pain; beginning at both knees and extending to the waist. There is a complete absence of muscle sense in both lower extremities. All reflexes are abolished, and there are no pathological reflexes. Light tapping of the patella tendon is said to produce severe pain in the lumbar region. No improvement since operation.

CASE III.—A. L., aged twenty-seven. On October 9, at Lens, the patient was lying face downward in a field, when he heard an explosion and at the same time felt a hot sensation in his back. He remained on his face, with no sensation in his lower extremities, and unable to move them. After ten hours he was taken to the rear. He had incontinence of urine and fæces.

On October 29 he was admitted to the American Ambulance in Paris. There is a circular healed wound of entry, on a level with the tenth dorsal vertebra, over the posterior surface of the left chest wall. There is œdema of the soft tissues of the lower part of the back. The patient presents a complete flaccid paralysis of both lower extremities, with an absence of reflexes and loss of muscular sense. The epigastric reflexes are preserved, the other superficial reflexes are absent. There is considerable atrophy of the muscles of the thighs and buttocks. There is a paralysis of the bladder with retention, and a paralysis of the rectum. Over the sacrum and coccyx there is a bed-sore, measuring 10 cm. by 6 cm., over which the skin is gangrenous.

The X-ray (Figs. 4 and 5) shows a shrapnel ball lying entirely within the spinal canal, directly in the midline, and opposite the intervertebral disc between the eleventh and twelfth dorsal vertebrae. There is also a small piece of shrapnel under the skin on the level of the ninth dorsal vertebra.

*Operation* (November 1).—Hemilaminectomy. An incision 10 cm. in length was made between the eighth dorsal and first lumbar vertebrae, and the usual exposure gained to the left side of the spinal column. The lamina of the last dorsal vertebra was removed. Its upper border was found to be injured as well as the lower border of the eleventh; undoubtedly caused by the entrance of the ball into the spinal canal at this point. Careful probing did not divulge the location of the ball, so the lamina of the first lumbar vertebra was removed, but without success. Upon removal of the lamina of the eleventh dorsal vertebra, the ball was discovered lying opposite the intervertebral disc, between the eleventh and twelfth, and was easily removed. At the point where the bullet lay, the dura was badly lacerated, and the cord was of the consistency of pulp. Closure of muscle and fascia with interrupted plain gut, closure of skin with interrupted silkworm-gut. Gauze drain down to muscle.



*Subsequent Course.*—The wound healed by primary union. No improvement since operation, except that the bed-sore presents a clean granulating base.

CASE IV.—P. N., aged twenty-eight. On October 29 the patient was standing, when he heard an explosion nearby. He threw himself to the ground, and as he was falling, was struck. He experienced a dull, heavy sensation in the back, and lay on his face, unable to move his lower extremities. He was taken to the rear at once, and was not catheterized before his admission to the American Ambulance in Paris, forty-eight hours later.

October 31: There is a small irregular-shaped wound of entry in the left flank, on the level of the tenth dorsal vertebra, and 5 cm. from the midline. The patient presents a complete flaccid paralysis of both lower extremities, bladder and rectum. The sense of position is entirely absent, as are the knee and ankle reflexes. There is a slight dorsal extension of both great toes, on stroking the soles. There is a faint response also to Oppenheim's method.

The X-ray (Figs. 6 and 7) shows an oblong piece of metal at the level of the intervertebral disc between the tenth and eleventh dorsal vertebræ, directed downward, backward, and to the left, and encroaching upon the anterior portion of the spinal canal.

*Operation* (November 14).—Laminectomy. An incision 10 cm. in length was made between the ninth dorsal and third lumbar vertebræ, and carried through the deep lumbar fascia. Parallel longitudinal incisions were made through the muscles on either side of the spinous processes, and the muscles separated from the laminae and retracted laterally. The spinous processes of the twelfth dorsal and first lumbar vertebræ were divided, and the muscle-bone flap reflected downward. In the same way the spinous processes of the tenth and eleventh dorsal vertebræ were divided and a similar muscle-bone flap reflected upward. The laminae of the first lumbar and eleventh and twelfth dorsal vertebræ were removed, and the dura opened longitudinally. The cord was found to be partially severed opposite the eleventh dorsal vertebra, and from the mutilated portion of the cord several fragments of bone were extracted. A metal rivet, which was firmly imbedded in the intervertebral disc between the tenth and eleventh dorsal vertebræ, was removed. The dura was closed with continuous plain gut suture. The muscle-bone flaps were brought together with plain gut sutures, and sutured laterally to the muscle edges. A gauze drain was introduced down through the muscle. The lumbar fascia was closed with interrupted plain gut, and the skin with interrupted silkworm-gut.

*Subsequent Course.*—The wound healed by primary union. No improvement since operation.

## GUNSHOT INJURIES OF THE SPINAL CORD

Subsequent to the operation, the patient told us that at the time he was wounded, his bayonet, which was hanging from the left side of his belt, was smashed to pieces. It was, in all probability, a rivet from his bayonet which was driven into his spinal column.

CASE V.—J. B. V., aged twenty-six. On November 26 at 3 P.M., the patient was standing, when he felt a dull heavy blow, and was thrown down. He experienced at once a loss of sensation in both lower extremities, and was unable to move them. He was moved to the rear at 7.30 P.M.

On admission to the American Ambulance Hospital, on November 28, examination showed a circular wound just above the supero-internal angle of the left scapula. Complete sensory and motor paralysis of both lower extremities, with absence of reflexes. The loss of sensation extends upward to the level of the fifth dorsal vertebra. There is a flaccid paralysis of the bladder and fecal incontinence.

The X-ray (Fig. 8) shows a shrapnel ball lying completely within the spinal canal, slightly to the right of the median line, and at the level of the intervertebral disc between the second and third dorsal vertebrae. (The radiographic print showing the lateral view was too dark for reproduction.)

*Operation* (November 29).—Laminectomy. An incision 10 cm. in length was made down the midline of the back, with the second dorsal vertebra as a centre. The aponeurosis was opened to either side of the spinous processes, and the muscles stripped laterally from the spines and laminae. The spinous processes of the second and third dorsal vertebrae were removed. The ball was seen between the laminae of the second and third dorsal vertebrae on the right side. It was easily removed from the spinal canal, through the aperture which it had caused by fracture of the lamina of the right side of the second dorsal vertebra. The laminae of the third dorsal vertebra were removed, and a blood clot found and removed from around the dura. The dura was opened to the extent of 2.5 cm., exposing an oedematous arachnoid membrane. The cord itself did not appear to be damaged. The dura was left open, and the muscles and aponeurosis closed with interrupted plain gut sutures, and the skin with interrupted silk-worm-gut.

*Subsequent Course.*—On the sixth day some of the skin sutures in the middle of the wound were removed, and the wound spread open at this point. Several other sutures were taken to bring the edges together again. The patient's temperature remained between 100° and 102°, with no explanation. On December 9 an abscess was discovered in the left buttock, which was opened. The patient became very much worse and died the next day.

December 11: Autopsy:

*Heart:* Flabby. The pericardial cavity is filled with a small amount of cloudy, yellow fluid. The parietal pericardium shows numerous small ecchymoses, irregularly distributed. The tricuspid valve admits two finger tips.

The right auricle and ventricle contain clotted blood. The blood content is entirely out of proportion to the size of the heart. On aspirating blood for culture, numerous air bubbles come up with the fluid aspirated. The mitral valve admits two finger tips easily. The left ventricle contains clotted blood in small amount. Post-mortem thrombus in pulmonary vessels and aorta. Pulmonic valves intact.

*Left lung:* Dilated. The pleural cavity is normal. Ecchymoses are irregularly distributed throughout the entire left lung, most marked in the anterior lobe and over the posterior margin of the diaphragmatic surface. On section the pulmonary vessels are found filled with blood clots. On sectioning the lung there are areas which stand out very prominently. These are infiltrated with blood and deep bluish-black in color. They are present in the upper and lower lobes, with marked congestion and oedema of the lower lobe. Pulmonary thrombosis is present, leading down to consolidated areas. The bronchial glands are swollen and soft.

*Right lung* is voluminously distended. There are numerous areas of hemorrhagic consolidation. These areas are more marked in the lower lobe.

*Tongue:* Negative.

*Tonsils:* Slightly enlarged but otherwise normal.

*Larynx and trachea:* Catarrhal inflammation of the mucosa.

*Thyroid gland:* Enlarged, no struma.

*Cervical glands:* Enlarged.

*Oesophagus:* Normal.

*Spleen:* Greatly enlarged, soft, somewhat flabby. Weight, 380 gm. The notches stand out very prominently. Soft and very friable on section.

*Suprarenals:* Negative.

*Right kidney:* Large. The capsule strips very readily. The cortex is slightly congested and increased in size. The markings are somewhat pale and cloudy. The pelvis is thickened and injected.

*Left kidney:* Swollen and injected. The cortex is markedly congested. Small yellowish, circular areas, surrounded by reddish areolas, and coalescing in spots, are seen on section.

*Ureters:* The mucous membrane is injected, and there are marked inflammatory changes in the lower third.

*Liver:* Parenchymatous degeneration. Hemorrhagic infiltration of the periportal tissues.

*Mesenteric glands:* Enlarged.

*Small intestine:* There is slight congestion of the duodenum, and ulcerations of the jejunum and ileum. The follicles of the ileum stand out very prominently. The blood-vessels are markedly injected throughout the intestinal tract. Numerous areas of hemorrhage are present.

*Large intestine:* The walls are thickened.

*Brain:* On removal of the calvarium, the vessels of the scalp bleed profusely. The dural vessels are injected. The vessels of the pia contain

## GUNSHOT INJURIES OF THE SPINAL CORD

numerous gas bubbles. The posterior cerebral fossa contains an increased amount of serosanguineous fluid.

*Spinal cord:* Removed.

A circular wound is present just above the supero-internal angle of the left scapula, which passes obliquely downward, inward, and slightly forward to the level of the second dorsal vertebra. The dura mater overlying this area is injected and surrounded by tissue filled with blood clots.

An area of discoloration, with a solution in the continuity of the skin, is to be seen over the left buttock. The buttock is markedly swollen, and on section reveals a track lined with necrotic, discolored tissue, which leads down to about the level of the ischial tuberosity of the left side, where an abscess cavity of the size of a small orange is found. This cavity contains a thick, chocolate-colored, grumous pus, and is lined by an area of bluish-black discolored muscle. The discoloration extends for the distance of 10 cm. in depth. The muscle of this area is dry, cloudy and somewhat discolored, giving the appearance of boiled beef.

The tissues over both heels are dry and bluish-black in color.

The cause of death was an infection from the *bacillus aërogenes capsulatus*, having its origin in the abscess in the buttock.

In reporting these cases, I am much indebted to Dr. Craig for his careful neurological examination of the patients and his advice at operation; to Dr. Jaugeas for his excellent radiographs; and to Dr. Jablons for his complete autopsy report.

## PERFORATING GUNSHOT WOUNDS OF THE ABDOMEN

REMARKS ON A CONSECUTIVE SERIES OF TWENTY-SEVEN CASES WITH THREE DEATHS

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THE management of penetrating gunshot wounds of the abdomen is the great branch of emergency surgery in which Southern surgeons have played a very conspicuous part. The late Dr. Hunter McGuire, in a paper read before the Virginia Medical Society in November, 1873, not only advised, but urged, the treatment of these cases by exploratory celiotomy.

As far back as 1606 Fallopius advocated enlarging the external opening to expose intestinal injuries and to practise enterorrhaphy. Between 1606 and 1849 the same opinion occurs a number of times in the literature. In 1849, however, Pirogoff definitely expressed himself in favor of a similar practice as being the only way to prevent death. He enlarged somewhat on the opinion of Fallopius and really advised more of a systematic operation. In 1863 Legouest wrote as follows: "In lesions of the intestines by cutting weapons attended by extravasation of solid or liquid contents, and in shot wounds, it is then proper to enlarge the external wound with the bistoury, to draw the intestine outward and close the solution of continuity by suture." In 1865 the very opposite opinion was expressed by Hamilton in his treatise on military surgery in which he says, "be assured that the patient will have a better chance for life if we let him entirely alone, and it surprises us that any good surgeon should think otherwise." Even Erichsen, as late as 1873, subscribed to a very compromising attitude about the management of intestinal perforations. He was not at all convinced in his own mind that surgery furnished even the best, say nothing of the only way, out of the difficulty. I have mentioned only a few of the surgeons whose work led up to the modern treatment of such conditions. An excellent article by McRae, of Atlanta, Ga., will give a splendid résumé of the history of this subject to those who are sufficiently interested to read it. As has already been indicated, the first real logical, clear-cut and sound statement of surgical principles and practice involved in the management of perforating gunshot wounds of the abdomen was given by the late Dr. Hunter McGuire before the Virginia Medical Society, in November, 1873. Dr. McGuire wrote as follows: "The wound in the abdominal



## PERFORATING GUNSHOT WOUNDS OF THE ABDOMEN

wall should be enlarged, or the linea alba opened freely enough to allow a thorough inspection of the injured parts. Hemorrhage should be arrested. If intestinal wounds exist, they should be closed, trimming their edges first if they are lacerated or ragged, blood and other extraneous matter should be removed carefully, and then, in my opinion, provision should be made for drainage. If the original wound of entrance is dependent, drainage may be secured by keeping this open. If the wound is a dependent one and the aperture of exit dependent, the patency of this should be maintained, and, if necessary, a drainage of glass or other material inserted. When there is no wound of exit and the aperture of entrance is not dependent, then a dependent counter-opening should be made and this kept open with a drainage tube. If it is urged that the means suggested are desperate, it can be said in reply that the peril is so extreme in cases as now treated that nearly all die, and I believe by the means I have pointed out in gunshot wounds of the abdomen the patient will exchange an almost certain prospect of death for at least a good chance of recovery." So we see that the principles of surgery as laid down by Dr. McGuire in 1873 furnish to-day the real ground-work for modern practice. Certainly Dr. McGuire was a bold, free and original thinker, and I might add in passing that he really did pioneer work in establishing the rational treatment of abscess appendix cases.

The next great impetus given to the management of gunshot wounds of the abdomen came from that truly creative genius and pioneer surgeon of the South, J. Marion Sims. We are in the habit of thinking of Dr. Sims's work as having to deal only with diseases of women. His work, of course, in this direction was extremely great. He was, however, a most accomplished surgeon. In 1881 in an article which appeared in the *British Medical Journal*, Dr. Sims, in discussing the question of gunshot wounds of the abdomen, expressed the following opinion: "Given a case of penetrating abdominal wounds, one should open the abdomen promptly, clean out the peritoneal cavity, search for the wounded intestine, pare its edges and bring them together with suture and then treat the case as we now treat other cases of injury involving the peritoneum. Rest assured that the day will soon come when, with an accurate diagnosis in such cases, followed by prompt action, life will be saved that otherwise must quickly ebb away." Shortly after Dr. Sims's paper, there occurred an article by R. A. Kinloch of Charleston, S. C., on gunshot wounds of the abdomen treated by opening cavity and suturing intestine. This paper was published in the *North Carolina Medical Journal* of July, 1882. This paper not only reported a success-

ful case, but in a straightforward and comprehensive way, advised treatment of such cases by exploratory coeliotomy. The paper of Kinloch's is entitled to rank with the work of McGuire and Sims. We think it but just and fair to say that the paper of Dr. McGuire before the Virginia Medical Society in 1873, the paper by Dr. Sims in the *British Medical Journal* in 1881, and the paper by Dr. Kinloch in 1882 really established the operation and placed it on a safe and sound surgical basis. The principles laid down by them furnished the basis of surgical work to-day.

It is extremely interesting to note the reduction of mortality: According to Matthews, among the British soldiers in the Crimean War the mortality in penetrating wounds of the abdomen was 92.5 per cent., and in the small per cent. of recoveries the proof is not positive that all wounds were perforating. Chenu gives the mortality among the French soldiers as 91.7 per cent. Otis has collected 3717 cases of gunshot wounds of the abdomen during the late American War and gives the gross death-rate at 87.2 per cent., and in 2599 cases where positive visceral injuries had taken place 92.2 per cent. died. In Moynihan's "Abdominal Operations," 1914 edition, you find the following paragraph:

Dr. Fetner (*ANNALS OF SURGERY*, vol. xxxv, p. 15) reports six cases of penetrating wounds of the abdomen treated by operation and gives statistical tables of 152 cases treated at the Charity Hospital, New Orleans, between January, 1892, and January, 1901. There were 96 cases of gunshot wound of the abdomen with visceral injury. Of these 71 died—a mortality equivalent to 73.95 per cent.

Such a death-rate is, of course, appalling. The mortality in cases operated on under modern conditions, such as the character of the projectile, is considerably lower than those of the American War. The most striking thing in the whole situation has been the gradual lowering of the death-rate until now it is quite common in the literature to find series of cases operated on with the mortality ranging from 15 to 25 per cent. and in some instances possibly lower than this. About 3 per cent. of all gunshot wounds received in battle involve the abdominal cavity, and about 0.8 per cent. of abdominal wounds fail to injure the intestines. In other words, 0.8 per cent. only of penetrating wounds of the abdomen fail to produce perforation of either the hollow or solid viscera. The question raised by this statement as to which cases would be explored is so plain "that he who runs may read."

In December, 1907, at the New Orleans meeting of the Southern Surgical and Gynæcological Association, I reported a series of eight consecutive, unselected cases of penetrating and perforating gunshot

## PERFORATING GUNSHOT WOUNDS OF THE ABDOMEN

wounds of the abdomen, with one death. Up to the present time 19 other cases have been added to this list with 2 more deaths and it is to this series of 27 cases with 3 deaths that I now particularly wish to direct your attention. A brief summary of these cases may be interesting.

The youngest case operated on was seven years, the oldest fifty-seven years. The average length of time that elapsed between the shooting and operation was between 8 and 9 hours. The earliest case operated on was 3 hours, and the latest 36 hours after injury.

The smallest number of perforations was 2, and the largest 22. The average number of perforations for the entire series about 9.

In 5 cases the injury was confined to the upper abdomen (above the umbilicus), and in 3 other cases both lower and upper abdomen were involved. Of the 5 cases in which the upper abdominal cavity was the seat of injury, once there were two perforations only in the transverse colon; 3 times colon, stomach and liver were injured, and once spleen and stomach. Of the 3 in which both lower and upper abdomen was involved, twice, besides three perforations to the small intestines, both colon and stomach were injured, and in 1 case with two small intestinal holes both colon and spleen were penetrated. In the remaining 19 cases the projectile did not enter the upper abdomen.

The ureter was divided low down in 1 case and we have been fortunate enough not to have had any of the great trunk vessels injured except in 2 cases that died. In about 10 cases there was a very serious hemorrhage from the injured mesenteric vessels.

The element of shock was very much more marked in the white than in the colored cases; in more than half of the colored cases the amount of shock present was a negligible factor, while only 3 out of the 12 white cases were not in a condition of serious shock, there being 12 white and 15 colored cases.

The only certain way to determine whether or not perforations have occurred is by operation and this should be done in practically every case. There should be no surmising whether the bullet has entered the abdomen and produced perforation or not. This question should be settled by exploratory celiotomy. Contrary to the general belief our opinion is that one should not be too precipitate in operating on these patients. I do not wish to be misunderstood here, for certainly things being equal, the surgeon who operates promptly after injury, who gets into the abdomen and out of it quickly, will have the best results. There is a vast difference between an operation quickly done

and one that is hurriedly done. I am also satisfied in my own mind that anything like an extensive soiling with peritonitis does not and cannot occur within 4 or 5 hours and there is strong evidence to show, owing to the paralysis of the bowel from the local and general shock of the trauma, that escape of intestinal contents does not occur markedly for 2 or possibly 3 hours. We are convinced, therefore, from a viewpoint both practical and theoretical, that while operation should be promptly done, it should not be hurriedly done. I am on dangerous ground right here; the point I wish to make is this: Not all, but quite a few, of these cases, especially where shock is present and hemorrhage not serious, will be made safer surgical risks by allowing them a reasonable time in which to react from the primary effects of the injury. Already some one has raised the question, how are you going to differentiate between shock and hemorrhage. My answer is, it cannot always be done, but, to the thoughtful man with training and experience, he will be able quite frequently to make the distinction. To me this is one of the very vital points in the paper, for we are convinced that a reasonable observance of this suggestion will occasionally turn the tide in our favor. After all, it reduces itself to a question of the surgical judgment, intuition and instinct of the individual operator.

Within limits that are reasonable, barring unusually severe injuries, the ordinary case is a good surgical risk when operated on between four and twelve hours after the injury. Some one has made the statement that the elapse of 12 hours or more between the occurrence of the accident and performance of the operation constitutes a contra-indication to operation. We take sharp issue with this statement, and, in support of the contention, submit the following: One case was operated on 24, one 36, one 18, two 12 and one 17 hours after injury and only one of these cases died. This is considered a sufficient answer to the above. If a patient suffering from one of these injuries presents himself for operation and has only one chance in a thousand to recover under surgical treatment, he should be given that chance and any time limit up to the point of the patient being moribund should be considered artificial.

Injuries above the umbilicus are more dangerous, harder to manage, and have a higher mortality than injuries to the lower abdomen; injuries to the large bowel we believe to be more dangerous than injuries to the small bowel, and for this reason, the contents of the small bowel are fluid and move rapidly, the fecal current reaches the cæcum and ascending colon where fluids are rapidly absorbed. The current becomes very stagnant. In the cæcum and that portion of the large intes-



## PERFORATING GUNSHOT WOUNDS OF THE ABDOMEN

tine where the storage function is greatest, conditions are ideal for the multiplication of bacteria and the intestinal flora attain their greatest virulence. Wounds which involve both large and small intestine are particularly dangerous, especially is this true where the portion of big bowel involved is cæcum or ascending colon. When such an injury accompanied by extensive hemorrhage is present, all the conditions necessary for a rapidly developing peritonitis are at hand and the highest mortality can be expected.

Our practice is to bring the patient directly to the operating room, where he is warmly wrapped and prepared for operation. He is given enough morphine to keep him from suffering and to help him recover from shock. Unless the patient is in first-class shape, he is given intravenously one or two pints of normal salt solution. When it is not desirable to give the salt solution directly into the veins, it can be given subcutaneously. When a donor is available, the condition of hemorrhage and shock can best be met by a direct transfusion of blood. When everything is in absolute readiness, we allow, according to indications, a reasonable time in which the patient can react before making the incision. The median abdominal incision is chosen under ordinary circumstances for reasons obvious to all. A very important matter in these cases is to get a correct idea of the track of the bullet, for in this way one is occasionally able to save much time and avoid a great deal of unnecessary handling of vital parts. Particularly should we be careful in handling the abdominal viscera which are painless to the sense of touch. It has been shown very recently in a splendid article in the *British Journal of Surgery*, for October, 1914, by Charles A. Pannett of London, that "Afferent impulses resulting from manipulation of the viscera have in general a more pronounced effect on the vasomotor centre than those resulting from the opening of the abdomen and the retraction of the edges of the wound." It would seem, therefore, that the handling of the intestines, which is painless in the ordinary understanding of the term, is a more serious thing than handling of the parietal peritoneum and skin, which are extremely painful to injury. The principle, therefore, in all such work, should be as gentle manipulation as possible.

It is extremely important to make a careful and systematic search of the entire intestinal tract. Our practice is to begin at some fixed point, generally at the junction of the small and large intestine, and while it is most unfortunate generally all of the small intestine has to be inspected. The large bowel can be treated with greater liberty. Each perforation is clamped as found and healthy intestine returned



to the abdomen. The large bowel is then gone over. Quite occasionally it is evident from the direction of the bullet that inspection of the entire cavity would not be necessary, but this question must be left to the surgical understanding of each individual surgeon.

Whether or not to irrigate the abdomen is another point about which there is much difference of opinion. In practically all cases in this series general irrigation of the abdominal cavity through a Blake's two-way irrigator was practised. This instrument is so constructed that the entire cavity can be irrigated without losing any time whatever in the operation or exposing the viscera to any unnecessary handling. The position of the irrigator is simply changed from one point to another as desired. We have never been able to see where it was harmful to gently irrigate the abdomen with hot normal salt solution in the presence of extensive infection. The more diffuse the peritonitis the greater the necessity for irrigation. The advantages to be gained by it are more than one and must be apparent to all of us. Occasionally where there is very limited soiling, irrigation has been dispensed with.

We do not practise irrigation in peritonitis from any other source. The question has been frequently asked, why do you irrigate in gunshot wounds of the abdomen and do not irrigate, for example, in a case of peritonitis from a ruptured appendix? This is a fair question and our answer is as follows: In a case of peritonitis from a ruptured appendix, there is, as a general rule, one orifice from which the infection comes. The soiling process is much slower and nature has a much greater opportunity to successfully localize and combat the spreading infection. There is, we believe, an unmistakable tendency towards successful localization of the infected area in peritonitis coming from this source, owing to the relative smallness of the peritoneal soiling, the natural forces working in the patient's behalf; to wit, his opsonins, his leucocytes, his resistance and ability to overcome the infection and develop immunity are far greater than, for example, in a gunshot wound of the abdomen that penetrates transversely the abdomen, opens the intestinal tract in possibly twelve or fifteen places, which will surely in a very short while turn loose an overwhelming amount of infectious material into the peritoneal cavity. While such a patient does not develop, in the full meaning of the word, a general peritonitis at once, he will certainly very promptly have a general soiling of the cavity. To put the case in a sentence, nature has a chance in one instance against what is a very small chance in the second instance. In the first case, she can care for a limited amount of soiling, in the second case the amount of infectious material is so great that she is overwhelmed. This we

## PERFORATING GUNSHOT WOUNDS OF THE ABDOMEN

believe to be the dividing line between irrigation and non-irrigation. At any rate, it is the basis of our reasoning and furnishes justification for the practice, bearing in mind always, with the method described above, the cleansing of the cavity and removing of infectious débris can be accomplished without handling of the viscera or, what is even worse, pulling on the mesentery or without unnecessary loss of time.

We must also remember that hours and sometimes days will elapse between the onset of acute inflammatory process and the occurrence of perforation. All during this interval between the acute attack and perforation, nature is getting ready to take care of the perforation when it occurs. The whole natural armament has been called out. The peritoneal cavity is in a very real sense not taken by surprise, but is prepared for the attack. The omentum is on its way, the leucocytes, the turbid lymphatic exudate which we find in so many of these cases is purely a conservative process and in conjunction with the other helpers at hand in the great majority of instances will successfully localize the infection.

Dr. Hunter McGuire and Dr. Sims both insisted on drainage. In our humble opinion this was a profoundly wise judgment on their part. We drain every case. I do not wish to appear dogmatic, but the rule should be—when in doubt, drain. A Keith's glass drainage tube is placed through the angle of the median incision into the Douglas pouch; depending on conditions a small Keith's tube is so placed as to drain each loin. On the patients' returning to bed they are placed in the exaggerated Fowler position unless the patient is so weak as to contraindicate it. This position one can get very readily by using the ordinary hospital roller chair. The continuous rectal instillation of normal salt solution is practised unless the large intestine has been injured. We stress the point that it is necessary to be very careful about suturing any rent in the mesentery, as occasionally one can have through such a rent an incarcerated bowel with obstruction. About 5 per cent. of these injuries die from tetanus, consequently on the first, fourth and sixth days after injury they are given an immunizing dose of anti-tetanic serum. If in the course of operation a segment of bowel is found with a number of perforations occurring close together, it will be conservative and occasionally life-saving to resect the intestine instead of suturing the individual perforation. Quite occasionally we have had recourse to this expedient.

In certain cases where one finds a portion of intestine of doubtful vitality, the patient's condition being extreme, a good thing has been found to bring such a piece of intestine into the wound, isolate it from

#### LEGRAND GUERRY

the rest of the peritoneal cavity by gauze sheets, leaving it here in a safe position to watch until such time as it can be repaired should it become necessary. It is better to assume this risk than to force an already over-taxed patient to stand a prolonged operation that may be fatal.

The late Dr. Homans, of Boston, once said that nine out of ten men knew what to do, but the tenth man knew what not to do. This statement is never more applicable than in relation to the subject under discussion.

As to the length of time to be occupied in these operations: These cases should be operated on just as quickly as is commensurate with thorough and careful work and no quicker. While the work should be rapidly done, it should not be hurriedly done, for there are other questions at stake and other things to be considered than the number of minutes taken to do the work.

## FRACTURE OF THE PELVIS

SYMPTOMS AND CLINICAL COURSE FROM A STUDY OF TWENTY-NINE CASES

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A RECENT publication by Jensen has drawn attention to the fact that fracture of the pelvis occurs more commonly than is generally supposed and forcibly impresses upon the surgeon the necessity of painstaking examination in doubtful cases of injury in the region of the pelvic bones, the examination to include the use of the X-ray in every case where trauma has been followed by pain referred to the pelvis, even in those cases where the pain is only moderately severe.

Jensen, working in Copenhagen, was able to collect 80 cases from the records of four general hospitals, covering a period of a little over five years. He lays special emphasis on the fact that many cases were unrecognized until long after the injury and that, owing to the supposed rarity of this condition, it was frequently overlooked even in patients who were under hospital treatment from the first. It was the desire to ascertain the comparative frequency of this condition in America, as well as to correlate Jensen's statistics with figures obtained from local records, that has led to the preparation of this paper.

The cases upon which the statistics presented herewith are based are taken from the hospital records of the surgical division of a New York City hospital<sup>1</sup> during a period of a little over six years, from February, 1906, to March, 1912. They represent the cases admitted to the hospital wards, but do not include a few cases which ended fatally, either shortly after the accident or in the emergency ward of the hospital within a few hours after admission.

Some idea of the frequency of fracture of the pelvis may be obtained when it is known that during the same period 143 cases of fracture of the femur and 16 cases of fracture of the vertebræ occurred. In other words, from the records of the Presbyterian Hospital, it would appear that fracture of the pelvis occurs about one-fifth as often as fracture of the femur and about twice as often as fracture of the vertebræ.

In Jensen's 80 cases there were 55 clinical cases and 25 which were taken from autopsy records; in the latter group were many cases in

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<sup>1</sup> From the surgical histories of the Presbyterian Hospital, New York City. My thanks are due to the attending surgeons for permission to study these records.



which the fracture of the pelvis was undiagnosed because the concomitant lesions (cerebral hemorrhage, intra-abdominal injuries, etc.) were usually so severe as to overshadow the symptoms referable to the pelvis. If we exclude cases of this type, which, owing to the paucity of post-mortem examinations in America, are frequently unrecognized, then Jensen's cases are, in the main, similar to the present series and may be fairly compared with them.

Fractures of the pelvis may be single or multiple according to whether one or more bones are broken. Fractures of the single bones occur most frequently and may, or may not, involve the true pelvis. The common type of these fractures is that which includes those involving the crest of the ilium, which, owing to its position, is frequently exposed to trauma. Fractures passing through the pubis and through the obturator foramen are considered as single fractures because the pelvic ring is broken in only one place, although in the fractures passing through the foramen, the line of fracture may pass through the ramus of the pubis above and the ramus of the ischium below.

Multiple fractures, on the other hand, usually signify that the line of fracture passes through the pelvis at two points, either the ilium and pubis, the pubis and sacrum, the rami of the pubis on both sides of the midline, or other combinations. Fracture with separation of the sacro-iliac synchondrosis or symphysis clinically falls under the same group as multiple fracture and is classed with it. Indeed, the combination of separation of the sacro-iliac joint and fracture through the obturator foramen is one of the most common types of multiple fracture. The sacro-iliac separation, moreover, is usually not a true disarticulation but is associated with fracture of the sacrum, or ilium, or both, the line of separation passing downward through the ilium to the synchondrosis and continuing through the bones, or, in some cases, branching through the sacrum.

An unusual fracture of the pelvis which deserves special mention is that of the acetabulum. This may consist of fracture of the rim of the acetabulum or the fracture of its floor, and is due to a trauma transmitted through the head of the femur. The force may be sufficient to drive the head of the femur through the floor of the acetabulum into the true pelvis. Skillern and Pancoast have reported eight cases of fracture of the floor of the acetabulum, in three of which the head of the femur was well within the pelvic cavity.

Fractures of the coccyx were not included in the present series because they form a separate class which has little in common with other fractures of the pelvis.



## FRACTURE OF THE PELVIS

In the discussion of the different types of fracture, Jensen classifies separately those cases which come to autopsy, and the clinical cases. His results are shown by the following:

Autopsy cases (total 25):

(a) Fracture of single bones:

Sacrum .....	1 case
Ilium .....	1 case
Ischium .....	6 cases

(b) Multiple fracture of the pelvic ring:

Double vertical (Malgaigne) .....	7 cases
Fracture and luxation .....	9 cases

(c) Luxation .....

Clinical cases (total 55):

(a) Fracture of single bones:

Sacrum .....	1 case
Ischium .....	1 case
Acetabulum .....	5 cases
Pubis .....	22 cases
Ilium .....	9 cases
Pubis and ischium .....	7 cases

(b) Multiple fracture of pelvic ring:

Double vertical (Malgaigne) .....	2 cases
Luxation and fracture .....	6 cases

(c) Luxation .....

It may be noted from the above that the multiple fractures are much more frequent among the autopsy cases. This is due, in part, to incomplete diagnoses in the clinical cases, but chiefly to the fact that cases coming to autopsy have suffered a much greater trauma than have the majority of the clinical cases.

In the present series, the division of cases was as follows:

(a) Fractures of single bones:

Ilium .....	9 cases
Pubis .....	8 cases
Ischium .....	4 cases

(b) Multiple fractures of the pelvic ring:

Double vertical .....	5 cases
Luxation and fracture .....	2 cases

(c) Luxation .....

In the present series three cases were compound, and the remainder were simple fractures.

The age seems to have little influence. Seven cases were under twenty years, twenty-one cases between twenty and fifty years and one case was seventy-two years old.

Corresponding with their more active life, men showed the greater liability to fracture of the pelvis (males, 21 cases; females, 8 cases).

*Fracture of the Ilium.*—The ilium was more frequently fractured than any other bone. Isolated fracture of the ilium occurred in nine cases of the present series. Fracture of the ilium was frequently the result of trauma of only moderate severity. Three cases were struck by moving objects and two others fell from vehicles.

In Case 2, a fireman, while hurrying to a fire, ran into a lamp post. The impact of the blow was received with greatest force in the region of the right hip. He was able to walk a short distance, but the pain became so severe that he was obliged to send for an ambulance. Another patient, also a fireman, was struck in the hip by a wagon. He did not consider his injury especially severe, and was able to walk back to the fire house. Later the hip became stiff and painful and the patient applied for treatment. In one case of this series (Case 25), the fracture was due to muscular violence. The patient, a young man of seventeen years, was running a race. He suddenly felt a sharp pain in the region of the hip and was obliged to stop. Examination showed a fracture of the anterior superior spinous process of the ilium with a moderate amount of separation. This type of fracture must be very rare; there was no instance of it in the 80 cases collected by Jensen, and I have been able to find no other in the hospital records. In 1906, Bebee collected four cases of this type of fracture from the literature.

As has been mentioned before, the symptoms of this injury are sometimes insignificant. Three of the patients were able to walk after the injury, and the diagnosis of fracture was made only through the X-ray examination. The symptoms were obscure and in a few cases could be distinguished only with considerable difficulty from fracture of the neck of the femur. Crepitus was frequently obtained and in several cases the fragment could be grasped between the fingers and moved freely. Ecchymosis was usually early and extensive. However, it must be emphasized that crepitus, false point of motion, and ecchymosis may all be absent in the presence of an extensive fracture of the ilium.

Serious complications are the exception in fractures of the ilium. Four cases were uncomplicated. In one case (Case 8) the fracture was compound. Subcutaneous hæmatoma occurred in three cases, one of which was infected. Abdominal complications (laceration of mesentery and peritoneum) occurred in only one case. Complications referable to the genito-urinary tract were also present in one case, but required no special treatment.

Only two patients required operation, and in one of these (Case 25) the operation was confined to the radical reduction of the fracture. In the other, the operation was a laparotomy with the repair of peritoneal lacerations. The prognosis of this type of fracture is good. Eight cases were cured and one case discharged improved. There were

## FRACTURE OF THE PELVIS

no deaths. The longest time spent in bed was 38 days, and the average time in bed was 27 days. Except in the two operative cases (Cases 12 and 25) the treatment was merely rest in bed with palliative measures toward the relief of pain.

*Fractures of the Pubis and Ischium.*—The fractures of the pubis and ischium may be conveniently discussed together. This is especially true because isolated fractures of the body or tuberosity of the ischium did not occur in this series. Fracture of the body of the ischium may occur in fracture of the floor of the acetabulum as previously described. Berry has reported an interesting fracture of the tuberosity which was caused by muscular action. Jensen reports that in his series of cases there was no fracture of the tuberosity of the ischium. The findings in the present series agree with his. Such a fracture must be extremely rare.

The line of fracture in this group of cases passes either through the body of the pubis (two cases) or, as is more common, through the thin rami above and below the obturator foramen. The mechanism of the fracture in most cases appears to be a combination of direct violence and compression; the pelvis, being exposed to a considerable force, breaks at the point of impact. However, the pressure may be so applied as to compress the pelvis from side to side, rather than anteroposteriorly, and in these cases the fracture of the pelvic ring occurs at its weakest point in a manner analogous to the "bursting fractures" of the skull.

The etiological trauma in fractures of the pubis and ischium is usually greater than in fractures of the ilium. In six cases the injury was due to a crushing force applied to the pelvis, such as a weight falling upon the body in the region of the pelvis (three cases), or an injury caused by the wheel of a vehicle passing across the pelvis (three cases). Only one patient included in this group was able to walk and in that case the patient walked only a short distance. The shock and abdominal symptoms were, as a rule, more pronounced than in the previous group.

Complications were much more frequent in this group than in the previous one. In five cases there were other fractures present and in six cases there were complications referable to the genito-urinary system. Abdominal complications were not frequent but in one case an extraperitoneal hæmatoma was so extensive that operative interference was required.

Operation was necessary in only three cases. The first was the laparotomy mentioned above in which exploratory cystotomy was done

for a suspected rupture of the bladder; the second case was an operation for traumatic rupture of the bladder and urethra; while the third consisted merely in the incision of a superficial hæmatoma.

There was one fatal case in this group, a child in whom the fracture of the pelvis was compound and associated with a traumatic amputation at the hip. Four cases were discharged improved and the remainder left the hospital "cured." Of the "cured" cases, the longest stay in bed was 57 days and the average period of treatment was 43 days, a period considerably longer than is the case in the fracture of the ilium.

Fractures of the sacrum may be mentioned here. There is no case in the present series, but the lower sacral vertebræ may be fractured in the same manner as the coccyx. Jensen found two cases in his series. They may be rarely associated with the crushing injuries of the pelvis.

*Multiple Fractures of the Pelvic Ring.*—In this group there were seven cases, five of which were double vertical fractures; the remaining two being fracture associated with luxation. What has been said regarding the mechanism of fracture of the pubis and ischium applies here as well, except that the trauma in these cases is usually more severe. In five cases of this group, the injury was caused by a fall from a height of from one to four stories. Two crushing injuries: one, a child, was run over by a heavy wagon; and the other, an adult, was caught beneath the trunk of a falling tree. As would be expected, none of these patients were able to walk, but in one case (Case 17) the amount of shock was slight in proportion to the injury.

Complications occurred in every case of this group. Coincident fractures occurred in two cases and complications referable to the genito-urinary system in five cases. One patient (Case 28) aborted a few days after admission and developed a septic temperature which lasted about two weeks.

Two cases came to operation, in one of which there was an extensive operation upon the urethra accompanied by the operative repair of the fracture. The second operation was an exploratory laparotomy for abdominal symptoms (Case 24) the cause of which was not determined.

Only one case remained in the hospital until able to walk about. In this case the patient was in bed for a period of 61 days. Four patients were discharged improved. In two of these the accident had occurred in attempting suicide and they were transferred because of their mental condition. Two other patients were discharged to receive further treatment at home. All of these cases, when transferred, were in good physical condition and were moved because active treatment



## FRACTURE OF THE PELVIS

was no longer considered necessary. Two patients died within 48 hours of the accident, neither of them recovering from the primary shock. In the entire series, there was no death from late complications, each of the three deaths occurring within a short period after the accident.

*Symptoms of Fracture of the Pelvis.*—Besides the local symptoms of fracture of the pelvis, there are a number of fairly constant associated symptoms which may conveniently be discussed together. These may be classified as general, abdominal, and those referable to the genito-urinary system.

The general symptoms are often overshadowed by those of the concomitant lesions, but even in uncomplicated cases, the shock is often severe. Death from the immediate effects of an uncomplicated fracture of the pelvis is rare. Jensen had only one case, a woman eighty years old, in whom death followed as a direct result of fractured pelvis. In the present series there was one patient who went into sudden collapse shortly after the accident (bleeding into the abdomen was suspected but an exploratory laparotomy was negative), no cause for the fatal issue being determined except pelvic fracture and acute alcoholism (Case 24).

In eight cases shock was severe and of considerable duration. In thirteen cases shock was of moderate severity and in the remaining cases there was only slight transient shock or none at all.

These latter cases are of extreme importance. It is not sufficiently appreciated that patients may have a fracture of the pelvic bones and still be able to walk and suffer little or no general inconvenience. Jensen reports cases in which the diagnosis was not suspected until months later when the patient came to the hospital for relief of permanent disability, the diagnosis of the fracture being finally made by means of the X-ray, much to the surprise of his physician who had been treating him for "traumatic sciatica" or "neurasthenic spine" or some other equally indefinite complaint.

Of the other general symptoms, fever was the most common. A temperature rising above 102 was present in 10 cases and a lower degree of temperature (between 100 and 102) was present in 13 cases. It is practically the rule in these cases to have some rise in temperature after the injury. The usual course is for the temperature to reach its highest point on the day after the injury and to fall gradually to normal in from six to ten days. In six of the ten cases, in which the temperature was 102 or over, the high temperature indicated a complication. In the other four cases there was no apparent cause for the fever except the fracture itself.



Abdominal symptoms were present in nearly every case. This is easily understood because of the wide attachment of the abdominal muscles to the pelvic bones. There are few pelvic fractures which are not, in some way, influenced by the tension of the abdominal muscles, and consequently a greater or less degree of rigidity, upon the injured side and of the group of muscles involved, is to be expected. Abdominal symptoms were marked in nine cases. Of these, four were operated upon and in two the condition was so bad that operation was not attempted.

In 17 cases the abdominal symptoms were moderate or slight, but while there is frequently a certain degree of rigidity, the tense board-like rigidity of inflammatory type is usually absent. In this condition a certain degree of conservatism is in order, and it is necessary to remember that a moderate or even marked degree of abdominal tenderness is not in itself a sufficient indication for laparotomy.

From a clinical point of view, the complications referable to the genito-urinary system are the most interesting and the most important. Of this series, excluding one case in which abortion followed the injury, there were 11 cases (38 per cent.) in which there were symptoms referable directly to the genito-urinary tract. In these, hæmaturia occurred alone in four cases, and retention of urine occurred alone in two cases. In five cases dysuria occurred, the catheterized urine being mixed with blood. The interesting fact in the above is, that of the ten cases showing either hæmaturia or retention of urine or both, there were only three operations and one death. The fatal case (Case 23), although showing definite symptoms of rupture of the bladder, was in such bad condition that no operative procedure was permissible. Of the remaining nine cases, three were operated upon, in one of which (Case 9) exploratory cystotomy was negative. In two cases (Cases 11 and 19) operative procedure was indicated and successfully carried out. From the above it is apparent that rupture of the bladder and urethra (occurring 3 times in 29 cases) is a less common complication of fracture of the pelvis than is generally supposed. Moreover, it would appear from a study of the case histories, that both hæmaturia and retention may be present after the injury and persist for several days or longer without indicating the necessity of operative interference. The discussion of the indications for operation and the type of operative procedure to be followed is not permissible within the limits of the paper; they are, however, of extreme importance.

*Treatment.*—The treatment of uncomplicated fracture of the pelvis

## FRACTURE OF THE PELVIS

has for its basis rest in bed in the position of greatest comfort. The treatment has been divided by Steintal as follows:

1. Treatment of the shock.
2. Treatment of the fracture by the reduction of the fractured bones, and their retention by means of sand bags, posture, etc.
3. Treatment of complications.

This third division should be subdivided to include the treatment of the early complications and the prevention and treatment of late complications.

The manual reduction may be accomplished in some cases by means of the finger introduced into the rectum or vagina. In selected cases, open reduction may be indicated. This is especially true in young women who may find in a badly united fracture a severe handicap to normal parturition. In double vertical fracture where almost the entire innominate bone is displaced upward and outward, a Buck's extension applied to the affected side may aid in securing the reduction of the fragment. The same apparatus may act for the relief of pain in fractures involving the acetabulum.

The duration of treatment depends upon the type and severity of the fracture. Fractures of the crest of the ilium may be allowed up after three weeks, while fractures of the pelvic ring should be kept in bed for at least six weeks or longer. In the severe types of fracture including the double vertical fracture, the patient should be kept at rest for a much longer period, eight or ten weeks or even longer. Most of the present series of cases left the hospital as soon as they were allowed to walk, the hospital treatment representing only the period of complete disability during which the patient was confined to bed. After leaving the hospital there is a long period of partial disability during which the pelvis may be supported by adhesive strapping, tight leather or elastic supports or other like appliances.

Still later symptoms due to the formation of an excessive amount of callus or the involvement of the sciatic nerve of the callus formation may indicate operation.

*Prognosis.*—The prognosis as regards life in uncomplicated cases is good. As has been previously noted, less than one per cent. end fatally. As regards the permanent return of function, the prognosis is less satisfactory. Steintal cites the figures given by the Austrian insurance companies. They consider that, even in bony union, the permanent injury to the adult earning capacity varies from 10 to 50 per cent. In cases where the union is fibrous the permanent injury to the earning capacity is usually as high as 60 per cent.

## A. CAMPBELL BURNHAM

TABLE I  
FRACTURE OF THE ILIUM

Case No.	Sex, Age, Etiology	Complications	Genito-urinary Symptoms	Operation	Days in Bed	Result
1	M. 47 years. Struck in hip	None	None	None	38	Cured.
2	M. 27 years. Ran against post	None	None	None	20	Cured.
3	M. 24 years. Struck in hip by automobile	None	None	None	9+	Transferred.
8	M. 45 years. Fell from carriage	Subcutaneous hæmatoma; compound fracture	None	None	29	Cured.
10	M. 22 years. Fell from wagon	Subcutaneous hæmatoma	Retention of urine; hæmaturia	None	28	Cured.
12	M. 11 years. Run over by wagon	Traumatic laceration of mesentery and peritoneum	None	Laparotomy and repair of lacerations	9+	Cured. Transferred home.
15	F. 4½ years. Hit by wagon	Infected hæmatoma	None	None	32	Cured.
20	M. 25 years. Fell three stories	Fracture of ribs	None	None	28	Cured.
25	M. 17 years. Sudden pain in hip while running	None	None	Radical repair of fracture	32	Cured.

TABLE II  
FRACTURE OF THE PUBIS AND ISCHIUM  
Fracture Through the Obturator Foramen

Case No.	Sex, Age, Etiology	Complications	Genito-urinary Symptoms	Operation	Days in Bed	Result
4	F. 7 years. Run over by automobile	Traumatic amputation of hip; compound fracture	None	None	1	Died.
5	M. 8 years. Run over by wagon	.....	Hæmaturia	None	10+	Home against advice. Cured.
6	M. 72 years. Fell 8 feet	Double Colles's fracture	None	None	30	Cured.
9	M. 26 years. Fell three stories	Prevesical hæmatoma; laceration of peritoneum; bed-sore	Hæmaturia; cystitis	Exploratory laparotomy and cystotomy	35	Cured.
13	M. 47 years. Fell 15 feet	Colles's fracture; contusion of chest; hæmoptysis	None	None	2+	Home against advice.
19	M. 28 years. Fell 12 feet; beam fell across abdomen	Fracture of ribs	Rupture of bladder; rupture of urethra; cystitis; pyelitis; retention of urine	Perineal and suprapubic cystotomy; repair of bladder and urethra	55	Cured.
21	M. 11 years. Run over by automobile	.....	Hæmaturia; retention of urine	None	4+	Transferred.
22	M. 33 years. Concrete; fell on pelvis	Infected hæmatoma	Hæmaturia; retention of urine	Incision of hæmatoma	45	Cured.
26	F. 35 years. Horse fell on abdomen	None	None	None	30	Cured.
29	F. 35 years. Fell 1 story	Fracture of ribs; Colles's fracture	Retention of urine; pyelitis; cystitis	None	51	Cured.

# FRACTURE OF THE PELVIS

TABLE II.—Continued.

## Fracture of the Body of the Os Pubis

Case No.	Sex, Age, Etiology	Complications	Genito-urinary Symptoms	Operation	Days in Bed	Result
14	M. 42 years. Fell 6 feet	None	None	None	16+	Home against advice.
18	F. 42 years. Fell 1 story	None	None	None	57	Cured.

TABLE III

## MULTIPLE FRACTURE OF THE PELVIC RING Double Vertical Fracture

Case No.	Sex, Age, Etiology	Complications	Genito-urinary Symptoms	Operation	Days in Bed	Result
11	M. 40 years. Hit by falling tree	.....	Retention of urine; rupture of urethra; cystitis; pyelitis	Suture of bone; urethrorrhaphy; external urethrotomy	61	Cured.
16	F. 23 years. Jumped three stories	Fractured humerus; psychosis	None	None	21+	Transferred.
17	M. 34 years. Fell 15 feet	Alcoholism	Hæmaturia	None	21+	Transferred.
23	M. 4 years. Run over by wagon	.....	Hæmaturia; retention of urine; rupture of bladder	None	2	Died.
24	M. 35 years. Fell from roof of stable	Fracture of ribs; alcoholism	None	Exploratory laparotomy	2	Died.

## Luxation and Fracture

Case No.	Sex, Age, Etiology	Complications	Genito-urinary Symptoms	Operation	Days in Bed	Result
7	M. 36 years. Fell 1 story	Prevesical hæmatoma	Hæmaturia	None	11+	Transferred.
28	F. 32 years. Fell 4 stories	Psychosis	Endometritis; abortion	None	47+	Transferred.

## Luxation of Symphysis

Case No.	Sex, Age, Etiology	Complications	Genito-urinary Symptoms	Operation	Days in Bed	Result
27	F. 32 years. Instrumental labor	None	None	None	51	One-half inch separation on discharge.

Pain, weakness, and a certain degree of lameness often persist for a long time after the injury. There is occasionally seen a chronic condition of invalidism similar to that seen after injuries to the spine.

The accompanying charts give in tabular form the causes, complications, and results of treatment in the different groups of cases, classified according to the character of the fracture. The diagnosis was made clinically, usually with the aid of the X-ray. In one case, the radiograph did not show a fracture although the clinical symptoms were absolutely typical. In the remaining cases radiographs were positive, but it is possible that in some cases the diagnosis was insufficient; that is, while a fracture of one bone was clearly demonstrated an associated lesion in another bone, or in another portion of the same bone, could not be positively excluded. In other words, some cases diagnosed as a fracture of a single bone were possibly multiple fractures. This fact should be borne in mind in studying the tables and due allowance made for individual variations.

#### REFERENCES

- Jensen: Baekkenbrud Hospitalstidende, November, 1912; Abs. Journ. A. M. A., 1913, ix, 170; also Beckenbrüche, Arch. f. klin. Chir., 1913, ci, 305.
- Bebee: Fracture of the Anterior Superior Spine at the Ilium by Muscular Force. N. Y. Med. Journ., 1906, 979.
- Berry: Fracture of the Tuberosity of the Ischium, Due to Muscular Action. Journ. A. M. A., 1912, lix, 1450.
- Fischer: Ueber schwere Beckenluxationen. Centralbl. f. Chir., 1909.
- Moritz: Fracture of the Pelvis Complicated by Laceration of the Femoral Vein Treated by Lateral Vein Suture. British Med. Journ., 1912, ii, September 28.
- McCarthy, J.: Fracture of the Pelvis Complicated by Extraperitoneal Laceration of Bladder. American Journ. of Urology, 1912, vii, July.
- Tillmanns: Verletzungen und Chirurgischen Krankheiten des Beckens. Deutsche Chir., 1905, Lief 62a.
- Skillern (Phila.): Additional Case of Fracture of the Acetabulum. N. Y. Med. Journ., 1913, xcvi, No. 25; also Case of Fracture of the Pelvis in a Child. N. Y. Med. Journ., 1913, xcvi, No. 19.
- Malgaigne: Traité des fractures et des luxations. 1855.
- Schürmann: Beckenbruch. Centralbl. f. Chir., 1907, xxxiv, 764.
- For complete Bibliography Previous to 1905 see Tillmanns' Deutsche Chir., 1905, Lief 62a.



## SIMULTANEOUS FRACTURE OF BOTH FEMURS

ONE TREATED BY PLATING, THE OTHER BY EXTENSION AND PLASTER-OF-PARIS CASE\*

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AND

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PATIENT, a man, fifty years of age, of good habits and fine muscular development, was brought to the Albany Hospital, October 29, 1912, having sustained, at the same moment, a comminuted fracture of each femur as the result of having been pinned between the side of a house and the rear of a heavily loaded wagon. The skiagraphs (Figs. 1 and 2) show the condition of the respective femurs on admission. It was decided to reduce the fractures under anæsthesia, and to apply a plate to the right bone and for the left to use extension and a plaster-of-Paris cast. This was done upon the day of his admission after a few hours of rest, about four o'clock in the afternoon.

The patient was under the anæsthetic a little over two hours. Owing to his exhausted condition it was not thought wise to take him to the X-ray room for other skiagraphs, but to remove him to his bed as quickly as possible. His case was one of some anxiety for the following twenty-four hours, when he reacted nicely and made an excellent recovery. The wound made by the plating operation healed kindly and without any complication whatever. The plaster bandage becoming somewhat loose was removed from the left leg December 17, 1912, an X-ray picture taken (see Fig. 3), and limb found to be in excellent apposition. Fig. 4 shows appearance of right leg on same date. By careful measurement, from the umbilicus, there was, perhaps, one-quarter inch shortening of the left femur. Plaster bandage reapplied to left leg, and aseptic dressings, with bandage, to right leg renewed. The patient was out of bed at the end of nine weeks, in a Morris chair, and encouraged to flex the knees and to begin the use of crutches, but this he found a very slow, painful process. There seemed to be a serious lack of confidence on his part in using the crutches; the fear of falling and not being able to bear much weight was very marked. February 25, 1913, plaster bandage removed from left leg, and there was evidence of good, firm union. Simple dressings applied, with bandage from the toes up, and the

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\* Read by title before the American Surgical Association, April 11, 1914.

## VANDERVEER AND VANDERVEER

patient then began the use of crutches with more earnestness. In time he found that one limb would support him quite as well as the other, using the crutches for two or three weeks, then two and, finally, one cane. The latter was given up in October, 1913, a year after the time of the accident. Since then he has walked very comfortably, with full confidence, and scarcely a perceptible limp, giving full attention to his occupation as Chief of Inspections in the New York State Department of Education.

April 10, 1914, the X-ray pictures present fully the condition regarding the appearance of the right leg (see Fig. 5) and (Fig. 6) of the left. In the latter, it will be noticed, there is a decided bending at the point of union, yet the patient is able to walk with comfort.

April 18, 1914, photographs were taken, from a side view, showing one limb to be about as straight as the other, while an anterior view (Fig. 7) shows a decided bowing outward of the left femur. A posterior view shows the bending even more markedly.

The last two X-ray pictures, together with the photographs of the left leg, demonstrate quite clearly that consolidation of the callus of the left leg has not been quite perfect, and that there has been a gradual giving away at the point of union; *i.e.*, a bending of the femur a long time after the patient was able to walk.

From this one case it is pretty positively shown that much better union was secured in the right femur by means of plating than by extension and use of plaster of Paris for the left leg.

Is it possible that the X-ray shadow gives an exaggerated expression of the deformity of the left femur? At the point of union, the right femur will be noticed a distinct separate enlargement, as though it might be the remains of the metal plate. On careful manipulation the patient has no pain nor can any sensation of a foreign substance be recognized.

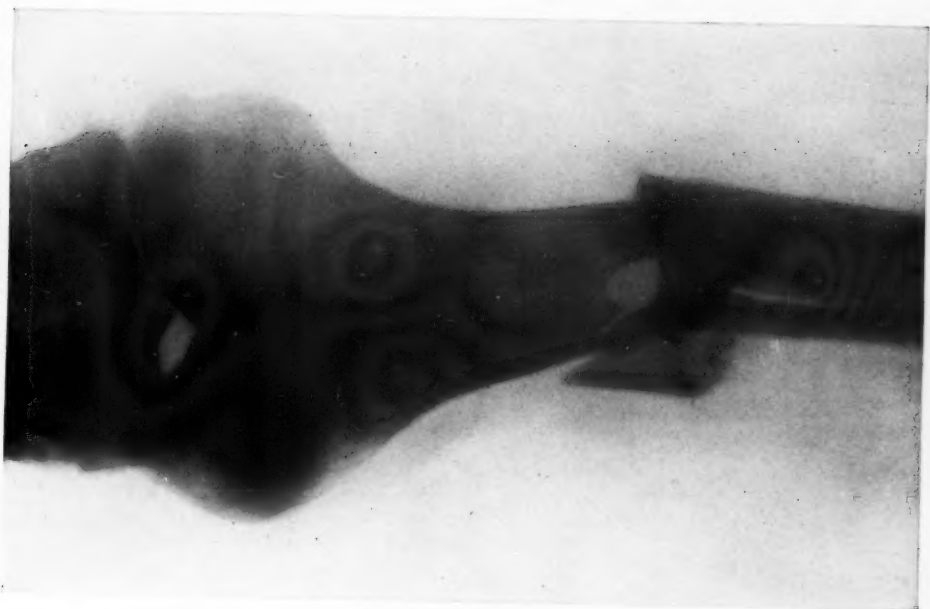


FIG. 1.—Left femur.

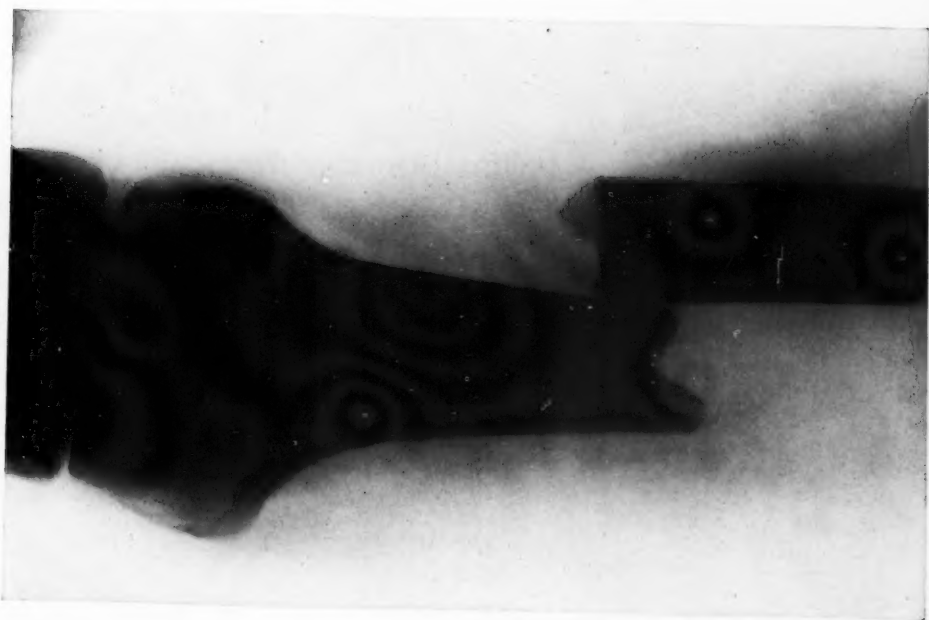


FIG. 2.—Right femur.

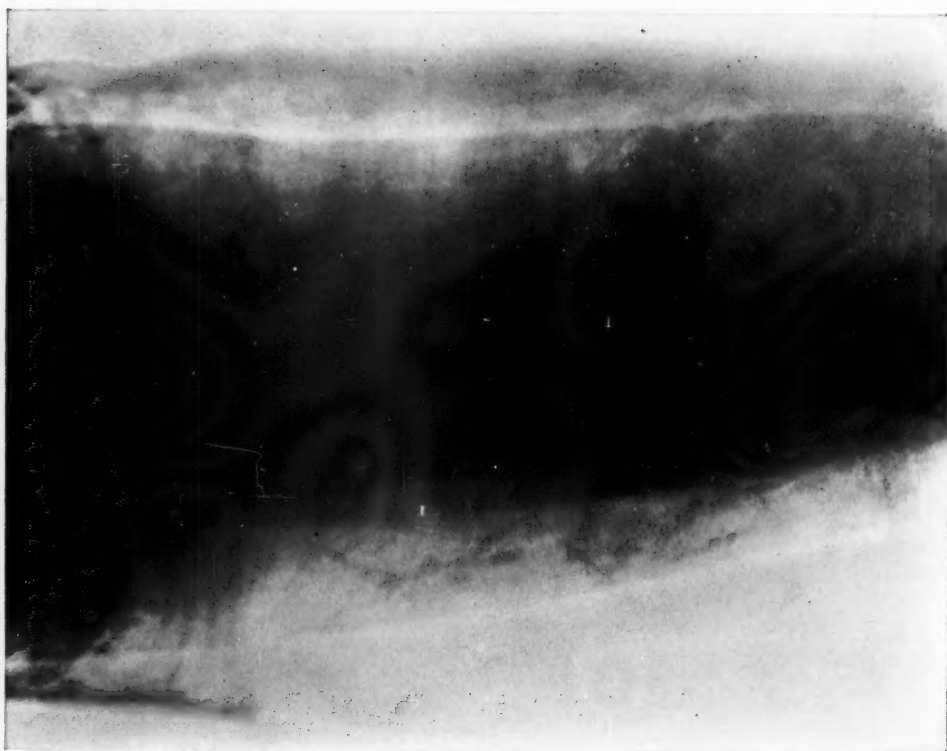


FIG. 3.—Skiagraph of left femur, 49 days after treatment by extension and plaster-of-Paris bandage.

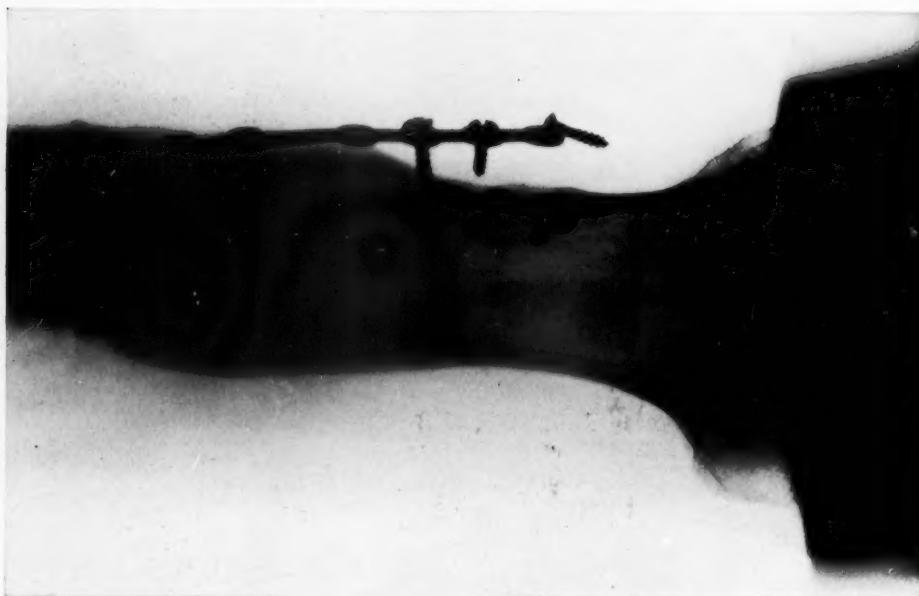


FIG. 4.—Right femur, 49 days after plating for fracture.

Fig. 5.—Right femur, April 10, 1914, five and one-half months after injury.

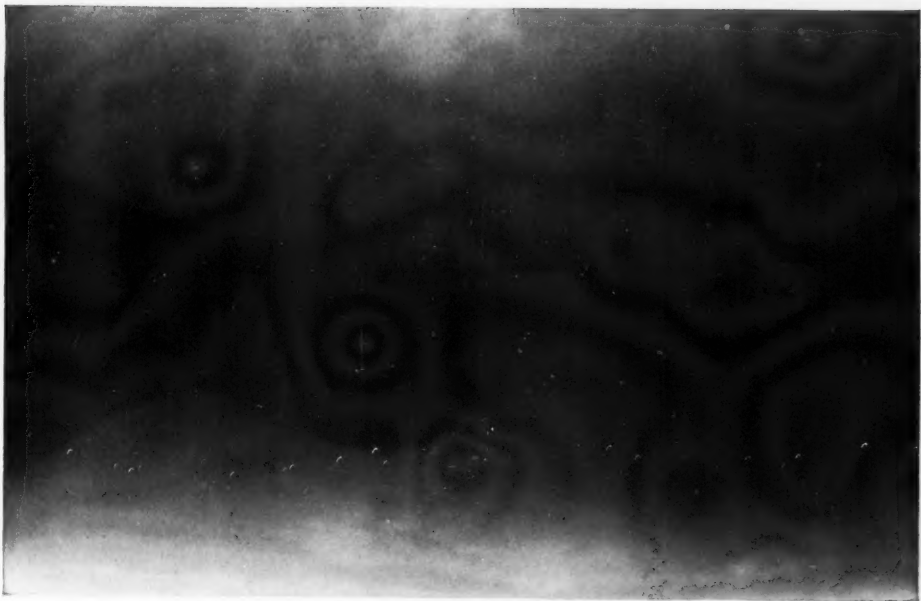


Fig. 6.—Left femur, April 10, 1914, five and one-half months after injury. Firm union with one-quarter inch shortening.





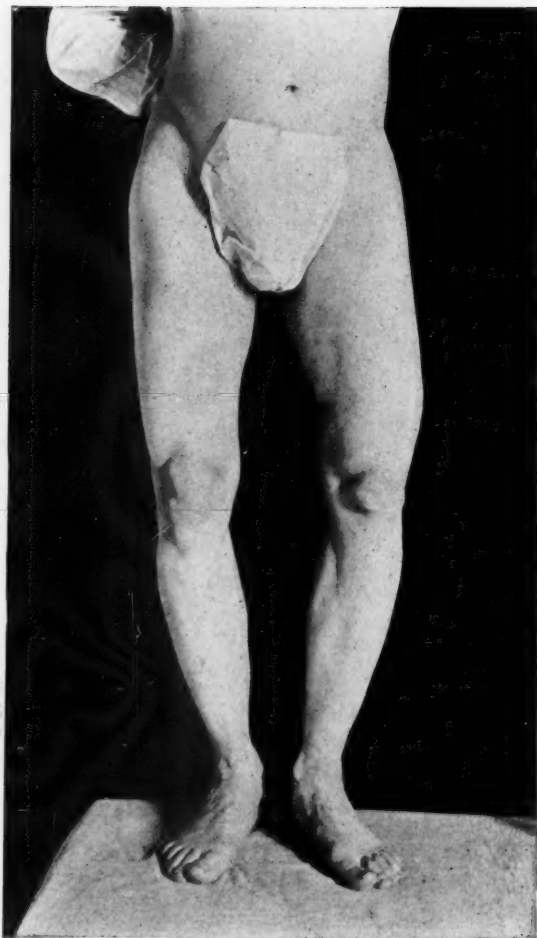


FIG. 7.—Anterior view, showing bend in left femur.

## AUTOGENOUS BONE GRAFTS VERSUS LANE'S PLATES

By HUGH H. TROUT, M.D.

OF ROANOKE, VA.

DUE largely to the efforts of W. Arbuthnot Lane there has been a renewal on the part of surgeons to coaptate fractures by means of foreign material and, while doubtless much good has been derived from such a procedure, there has been done an untold amount of damage. Such apparently easy mechanical principles have tempted many an ill-prepared operator to approximate fractures in which he would have previously employed far more conservative methods with less harm to his reputation and a great deal more comfort and satisfaction to his patient.

In reading the history of any buried material in the human body it is interesting to note how, in the process of surgical evolution, we return to either no buried material at all, or at least an absorbable material if anything is absolutely necessary. Personally, I do not believe any metal plate is going to be an exception to this general rule, and further think Lane's plate and all such heavy metal appliances to be buried, will soon be in disfavor except in the very exceptional cases.

During the past year there has been widespread dissatisfaction due to the troubles many surgeons are having with Lane's plates and we believe this is the result of trying to apply a wrong surgical principle to a general class of cases.

Inquiry made and replies received from over one hundred surgeons in America, reveal that all, with the exception of seven, have had to remove Lane's plates either in their own cases or those of some other surgeon. This shows clearly one of two conditions—either the Lane plate is wrong or the surgeons have applied it incorrectly. Personally, we believe it to be the former; but if it be the latter then we must understand more thoroughly the principles underlying the success of Lane's individual cases.

Great stress is laid by Lane on not allowing the fingers of the gloved hand to touch the plate and we all admire the manner in which he handles his plate with his special devised instruments, but such dexterity is not given to many. It does seem to us a plate which is aseptic will remain so if handled with an aseptic glove, and certainly the average

surgeon will cause less trauma to tissues with his hand than he would with steel instruments.

No attempt will be made to explain why callus formation is so much more active on the side of a fracture opposite to a Lane's plate, but such is a well-known fact to every surgeon. Figs. 1 and 2 simply serve to show two of our worst cases, in both of which the plate was removed with gratifying results.

A few months ago we completed, with the assistance of Drs. W. B. Foster and E. T. Brady, some experimental work on Belgian hares. Our first two series of animals were used to show the results on one hand of small vanadium steel screws in the presence of infection, while on the other the behavior of autogenous grafts under similar circumstances. Thirty-five rabbits were employed to illustrate the results when screws were inserted in the presence of infection, and 25 with the autogenous grafts.

The first 5 were injected with a culture of colon bacillus mixed with graphite. In this series we only obtained three abscesses, but with these three we made an incision through the abscess to the bone and placed a small Vanadium steel screw in the femur. In all three the screws finally came to the surface and were removed in 6, 10 and 41 days respectively. With the rest of this series we gave up the idea of trying to develop a certain type of abscess and decided to simply make an incision in the rabbit's thigh in as dirty a manner as possible and thus obtain an infected field through which to place our screws and at the same time we obtained a culture to ascertain the type of organism producing the infection. This was carried out in 30 rabbits, with the following results: Six rabbits died from the anæsthetic (ether), leaving 24 which had screws placed in either tibia or femur. In 2 (Nos. 6 and 12) the screws remained in position after developing sinuses, both of which finally closed; and in the remaining 22, all the screws came to the surface and were removed.

This series according to the type of infection is as follows:

BACTERIA FOUND IN RABBITS HAVING SCREWS INSERTED

- 1—*B. pyocyaneus* and a few Gram-positive diplococci.
- \*6—*B. coli* and a few Gram-positive diplococci.
- 7—Staphylococci, streptococci, and a Gram-negative bacillus.
- 8—*B. pyocyaneus* and streptococcus.
- \*12—Staphylococci, streptococci and Gram-negative bacillus.
- 13—Staphylococci, streptococci and a few Gram-negative bacilli, *B. pyocyaneus*.
- 14—*B. pyocyaneus* and staphylococci.
- 15—*B. coli* and staphylococci.

## AUTOGENOUS BONE GRAFTS VERSUS LANE'S PLATES

- 16—Staphylococci and a few *B. pyocyaneus*.
- 17—Gram-negative bacilli and a few Gram-positive bacilli and cocci.
- 18—*B. coli*.
- 19—Gram-negative bacilli and a few cocci.
- 20—*B. pyocyaneus* and a few cocci.
- 21—Staphylococci, streptococci, a Gram-negative bacillus, probably *B. coli*, and Gram-positive bacilli.
- 23—Staphylococci, streptococci, and a few *B. pyocyaneus*.
- 24—Gram-negative bacillus, a few cocci, and Gram-positive bacilli.
- 25—Staphylococci and *B. pyocyaneus*.
- 27—*B. coli*, *B. pyocyaneus*, and a few streptococci.
- 40—*B. pyocyaneus*.
- 41—*B. pyocyaneus*.
- 42—*B. pyocyaneus*.
- 43—Staphylococci and *B. pyocyaneus*.
- 44—*B. coli* and *B. pyocyaneus*.
- 45—*B. pyocyaneus* and a few staphylococci.

We next determined to ascertain the fate of an autogenous graft placed through an infected field in the same manner in which we had inserted our screws. The manner of obtaining the graft was simply to remove a small piece of bone and transfer it to the other leg—in other words, to take from the left and place on the right; and from the right and place on the left.

In this series we employed 25 rabbits, 3 of which died from ether, leaving a series of 22 rabbits having 44 grafts. Five of the bone grafts worked out (No. 50 right, No. 55 left, No. 60 left, No. 81 right, No. 87 right) while in the remaining 39 the grafts all apparently "took" and were found in place by X-rays and later on autopsies.

The grouping according to bacteria is as follows:

### BACTERIA FOUND IN RABBITS HAVING AUTOGENOUS GRAFTS

- 49 Right—*B. coli*, *B. pyocyaneus*, and a few cocci.  
Left—*B. coli* and *B. pyocyaneus*.
- 50 \*Right—*B. Pyocyaneus*.  
Left—*B. coli*, *B. pyocyaneus*, and streptococci.
- 51 Right—*B. coli*, *B. pyocyaneus*, and a few Gram-positive bacilli, with metachromatic granules.  
Left—*B. pyocyaneus*.
- 52 Right—*B. pyocyaneus*.  
Left—*B. pyocyaneus*, *B. coli*, and staphylococci.
- 53 Right—*B. pyocyaneus* and staphylococci.  
Left—*B. coli* and *B. pyocyaneus*.
- 54 Right—*B. coli* and *B. pyocyaneus*.  
Left—*B. pyocyaneus* and a Gram-positive bacillus.
- 55 Right—Staphylococci and *B. pyocyaneus*.  
\*Left—*B. pyocyaneus* and a few cocci.

# HUGH H. TROUT

- 56 Right—*B. pyocyaneus* and a few Gram-positive bacilli.  
Left—*B. pyocyaneus* and a few Gram-positive bacilli with metachromatic granules.
- 57 Right—*B. pyocyaneus*.  
Left—*B. pyocyaneus* and a few Gram-positive bacilli with metachromatic granules.
- 58 Right—*B. pyocyaneus*.  
Left—*B. pyocyaneus*.
- 59 Right—*B. pyocyaneus* and a few Gram-positive bacilli with metachromatic granules.  
Left—*B. pyocyaneus* and a few staphylococci.
- 60 Right—*B. pyocyaneus* and a few Gram-positive bacilli with metachromatic granules.  
\*Left—*B. pyocyaneus* and a few Gram-positive bacilli with metachromatic granules.
- 75 Left—A Gram-negative bacillus.  
Right—Gram-positive and Gram-negative bacilli and a few cocci.
- 76 Left—Large Gram-positive bacillus, Gram-positive diplococcus and Gram-negative bacillus.  
Right—Staphylococci and Gram-positive and Gram-negative bacilli.
- 77 Left—Staphylococci, Gram-negative diplococci, and Gram-positive bacilli.  
Right—Gram-positive bacillus and staphylococci and Gram-negative bacillus.
- 80 Left—*B. coli*, staphylococcus aureus, and a Gram-positive bacillus.  
Right—Staphylococci, Gram-negative bacillus and diplococcus, and a Gram-positive bacillus.
- 81 Left—*B. coli*, Gram-positive diplococcus and a few Gram-positive bacilli.  
\*Right—Staphylococcus aureus, and Gram-positive and Gram-negative bacilli.
- 87 Left—Staphylococcus aureus and Gram-positive bacillus.  
\*Right—Staphylococcus and Gram-positive bacillus.
- 88 Left—Staphylococcus aureus, Gram-positive bacillus and Gram-negative diplococci.  
Right—Staphylococcus aureus and Gram-negative diplococcus.
- 89 Left—Staphylococcus aureus and a small Gram-positive bacillus.  
Right—Gram-positive bacilli (white and yellow colonies).
- 90 Left—Gram-negative bacillus and Gram-positive bacilli and diplococci.  
Right—Little growth, Gram-negative bacillus.
- 91 Left—Staphylococcus aureus, Gram-positive and Gram-negative bacilli.  
Right—Staphylococcus aureus and large Gram-positive bacillus.

In other words, in these infected cases 92 per cent. of the screws had to be removed while 8 per cent. remained after developing sinuses. With the autogenous bone grafts only 11 per cent. were removed and 89 per cent. remained in place, as proven by X-ray and on killing the rabbits four months after the insertion of the grafts and finding them apparently continuous with the rest of the bone.



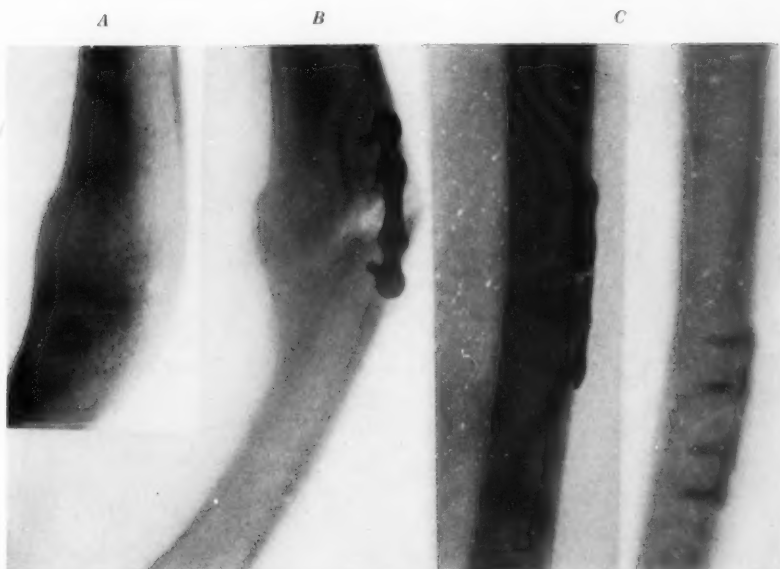


FIG. 1.—Ununited fracture of femur, due evidently to the Lane plate. *A*, six months after removal of Lane plate. *B*, six months after insertion of Lane plate. *C*, one week after insertion of Lane plate. Taken with portable X-ray.

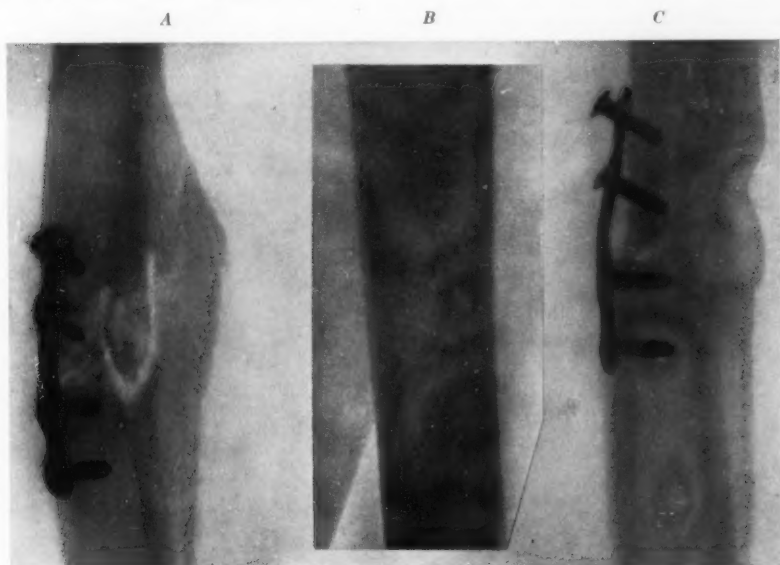


FIG. 2.—Ununited fracture of the humerus due to Lane plate. Notice lack of callus in region of Lane plate. *A*, three months after insertion of Lane plate. *B*, three years after removal of Lane plate. *C*, three months after insertion of Lane plate.



FIG. 3.—Case I. A, infected fracture of tibia and fibula, before operation. B, photo of bone after removal.

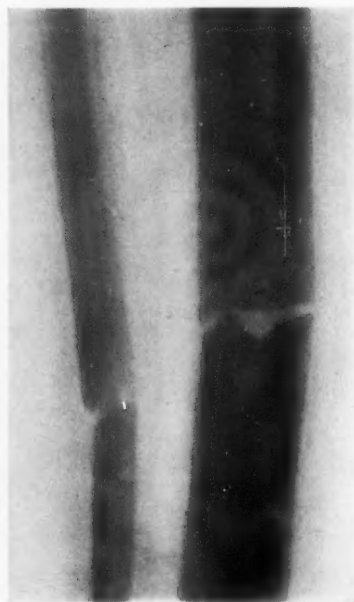


FIG. 4.—Case I. X-ray two weeks after operation.



FIG. 5.—Case I. Ten months after operation.



FIG. 6.—Case II. Infected fracture three weeks after injury.

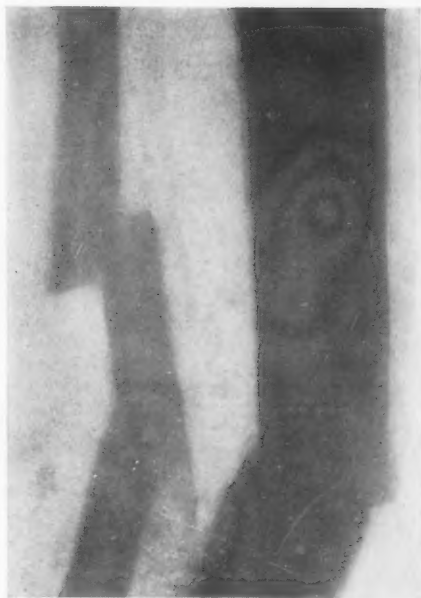


FIG. 7.—Case II. X-ray before operation, showing fragment of fibula to be utilized for making grafts and pegs.



FIG. 8.—Case II. X-ray three weeks after operation. Escape of intramedullary peg from lower end of fibula.



FIG. 9.—Case III. Epiphyseal separation of humerus with outward rotation of articular surfaces.

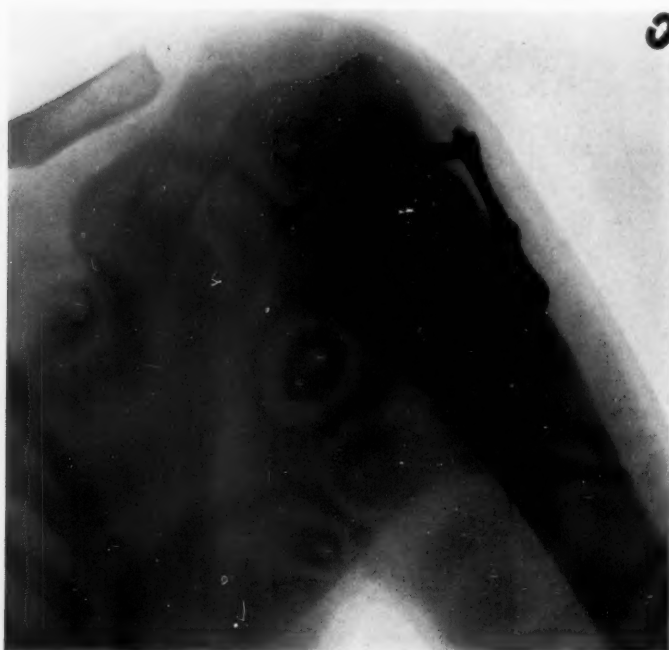


FIG. 10.—Case III. After insertion of Lane's plate, with shortening of arm.



FIG. 11.—Patient twelve years old. Epiphyseal separation of humerus held in place by means of an autogenous bone peg from crest of tibia. X-ray one week after operation.



FIG. 12.—Patient ten years old. Epiphyseal separation of humerus held in position by means of autogenous bone peg. X-ray one week after operation, on December 19, 1913.

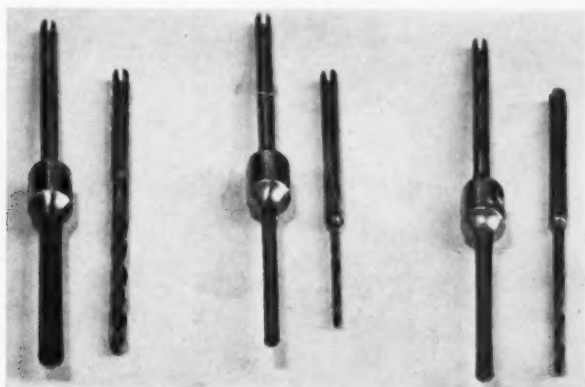


FIG. 13.—Reamers or dowels with drills of same size.



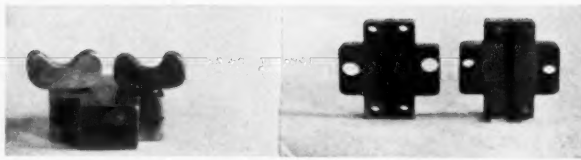


FIG. 14.—Mould for making screws of autogenous bone pegs.

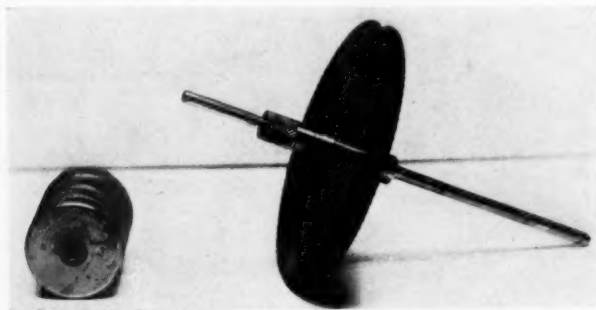


FIG. 15.—Parallel saws and guide. Notice different sized washers on the shank which can be inserted between the saws.

## AUTOGENOUS BONE GRAFTS VERSUS LANE'S PLATES

These two series demonstrated experimentally: First, a foreign body is far more apt to give trouble in the presence of infection than an autogenous graft and, second, an autogenous bone graft will "take" in a proportion of cases in the presence of various types of acute and chronic infections. Not for one moment, however, do we want to be understood to advocate any relaxation in aseptic technic, for absolute cleanliness is as essential in this class of work as it is in any other field of surgery.

CASE I demonstrates better than any other case we have had the possibility of bone grafts taking in the presence of active infection.

CASE I.—Young man, twenty-two years old; compound comminuted fracture of left tibia and fibula eleven weeks before admission to the hospital. X-ray (Fig. 3) showed not only the fracture but a detached piece of bone (Fig. 3, B), and, on exposure of fragments, pus (smears of which showed the colon bacillus predominating) was found permeating all the tissues and about 200 c.c. escaped after incision of skin.

It was decided to try an autogenous bone inlay graft in spite of the infection. This was done on December 29, 1913, and as follows: Incision was made and dead bone removed; after which two parallel circular saws were used for making a groove, the pieces removed being utilized for the manufacture of five bone pegs, one of which was inserted as an intramedullary peg in the fibula. The other four were employed to hold in place a graft which had been removed from the upper part of the tibia. This last graft was obtained with the two circular saws, but now being separated by a washer, the thickness of the "set" of the two saws, so as to make the graft fit tightly in the groove prepared for its reception. In other words the washer allows for the "saw dust." Figs. 4 and 5 show the case in two weeks, and ten months, respectively; and the patient has a perfect functional result without any of the pegs or grafts ever coming to the surface—and this in spite of the fact that there was almost constant drainage of pus for about two weeks following the operation.

The oldest case in which we have employed an autogenous graft in infected fields is sixty-six years, this also being a compound fracture of tibia and fibula. Fig. 6 shows the leg on admission three weeks after injury; Fig. 7 the X-rays before operation, and Fig. 8 the X-ray three weeks after operation. This old gentleman is still in the hospital (four weeks after operation) with every indication of having good union of tibia, but the intramedullary peg in the fibula has escaped from the lower fragment. The graft and pegs were made from the piece of the fibula seen

between the two fractures of this bone. As this patient has an ankylosed and bent knee on the other leg this shortening of about two inches makes no difference as regards the usefulness of the leg.

We next determined to ascertain the results of a foreign body placed in the epiphyseal line upon the future growth of that bone in its long diameter in comparison with an autogenous peg under the same conditions.

A small vanadium steel screw was placed in the epiphyseal line of tibia in a series of 10 young rabbits varying in age from 4-6 weeks. This was done through as near an aseptic field as possible to obtain and all rabbits showing any signs of infection were discarded. The hair was removed with barium sulphide and starch and the field cleaned up in the usual manner—X-rays were then taken on the following day to ascertain accurately the relative position of the screw, and at the end of six months all the rabbits were killed. In 4 of these cases there was a shortening of the tibia having the screw, varying between one-half and two centimetres. There was no ascertainable difference in 6. In addition to this series there were 12 rabbits that had to be discarded because the screw was not in the epiphyseal line, and 7 on account of sinuses and infections.

An autogenous spicule of bone was placed in the epiphyseal line of the tibia in a series of 12 young rabbits in a manner similar to that in which the screw had been placed, and in none of these cases was there any shortening—rabbits being killed in the same length of time. In other words, with steel screws, 40 per cent. of the cases showed shortening in the long diameter; while with the autogenous pegs there was no shortening in any case.

Meissenback, in 1910, injected sterile water, tr. iodine, alcohol, carbolic acid, formalin, various bacteria, etc., in the epiphyseal lines of a series of hares, and found some of these, formalin especially, stimulated osteogenesis; but on the other hand concluded a "retardation of growth may occur if the zone of provisional calcification is destroyed or if this zone is infiltrated by excessive blood clot or by destructive processes." It is this permanent destruction we feel occurs by the placing a screw in the epiphyseal line, while with an autogenous peg such destruction is not permanent.

The importance of this part of the work is shown in the case of a small boy, aged ten years, who had an epiphyseal separation with rotation outward of the articular head of humerus to such an extent it was impossible to reduce it without open operation (Fig. 9). The fragments were returned to their normal position, as shown in Fig. 10, and held in position by means of a Lane's plate. This operation was done on September 1, 1912, and on October 8, 1914, the date on which the plate was removed, there was about three centimetres shortening of the right (af-

## AUTOGENOUS BONE GRAFTS VERSUS LANE'S PLATES

fect) arm. With this exception the boy obtained a perfect result and it will be most interesting to watch the future development of the length of the arm without the plate.

Figs. 11 and 12 show two similar cases in which autogenous bone pegs were employed instead of Lane's plate and, while the time has not been as long, as yet there are no signs of shortening and both results are perfect as regards function. Both of these cases have been done over a year and the case in which Lane's plate was employed showed shortening in about six months, which at first was thought to be due to disuse of arm, but after return of full use of the arm and increased exercise it failed to develop as rapidly as the other arm.

Every surgeon who expects to do any of this type of bone work should be equipped with an efficient electric motor, and we have found a friction-driven motor far more satisfactory than the heavy gear-driven motors on the market under various names.

The hand gear motors are heavy and cumbersome, while with a flexible shaft the surgeon has no weight to hold—in addition to this the friction-driven motor possesses the advantage of not breaking the bone, should the saw or dowel bind—a condition of affairs not at all infrequent, no matter what type of machine is being employed. When binding occurs with a gear-driven machine without a flexible shaft something is going to break and it is more apt to be the bone than the gears or saw. A foot control so arranged as to regulate the speed of the motor as well as to turn on and off the current is of great comfort and safety to the surgeon. Before any surgeon tries to use an electric motor he should practise on animal bones and thoroughly understand how to handle the machine in every respect. All metal parts of the machine which come near the field of operation can be boiled and the flexible shaft can be covered with a sterile bag about four feet long, three inches wide, open at each end, and tied with a purse string.

In the *Journal of the A. M. A.*, April 4, 1914, we published a description of our dowels or reamers which we had then been using about two years and have found satisfactory in every detail.

These, as can be seen in Fig. 13, are simply three cylinders of different sizes, at one end of which is a sawing edge. This end is placed over the fragment of bone to be fashioned into a peg and then the motor started. It only requires a few seconds to obtain a peg several inches long. The size of peg required depends on the strain to which the peg is to be placed. We have usually employed the smallest size; though for an intramedullary peg the largest size is most frequently used. The strength of these pegs is surprising to one unaccustomed to them. In making these pegs it is best to allow a few drops of normal saline solution to play in front of the cutting edge so as to prevent any possibility of heating the

bone. Not infrequently one can obtain several pegs from a fractured spicule of bone. In very oblique fractures it is not necessary to use an inlay graft but just simply to nail the fragments together with several of these pegs.

Of course, the drills correspond in size to the pegs. If one wants to manufacture an autogenous bone screw this is easily done by placing a peg in a mould (Fig. 14) and screwing down the "lugs." This impresses us as being a useless refinement and not possessing sufficient advantage to justify the waste of time.

The grafts can be held in place by catgut, but this requires about as much time to thread in place as it does to make and insert the pegs, and certainly a graft held by catgut is not as firm as one anchored with the pegs.

We have found the parallel saws (Fig. 15) easy and quick to operate and are sure that having this little washer to place in between the two blades to allow for the "saw dust" makes a far more satisfactory and certainly a more accurate operation and does away with the necessity of calipers or any other forms of measurement.

It is occasionally necessary to remove bone from parts remote to the fracture and for this purpose we have always employed the crest of the tibia. This should never be done except when absolutely necessary, for such practically means two operations. If one is prepared to do these operations and has practised on fresh animal bone sufficiently to handle the instrument, there is no reason why they should not be done quickly and accurately, but it is most certainly an operation not to be undertaken "lightly and ill-advisedly."

We have made no mention of the rôle played by the periosteum in the repair of fractures, nor have we advanced any theory concerning the life of the grafts or pegs as regards their absorption or serving simply as a framework for new bone deposits, for to consider any of these points would constitute a separate essay. To be convinced of this one has only to review the literature published on these subjects during the past two or three years and then to consider the existing confusion—some of which seems to be due to a difference of opinion of what constitutes the true periosteum; whether the outer fibrous layer by itself or whether taken in conjunction with the underlying layer containing osteoblasts.

SUMMARY.—First, Lane's plate or any foreign material will limit osteogenesis in region of fractures.

Second, In the presence of the various types of infections Lane's plates have to be removed—autogenous grafts seldom do.

Third, Lane's plates placed in the region of the epiphyseal line in the young limit the growth of that bone in the long diameter in a large per cent. of cases, while autogenous pegs do not.

Fourth, A certain percentage of Lane plates have to be removed, whether in the presence of infections or not.



## PAPILLOMA OF THE GALL-BLADDER

REPORT OF 85 CASES

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AND

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OF

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PAPILLOMATA of the gall-bladder have been seen so frequently in the experience of the writers and have received so little attention in literature that it seems advisable at this time to describe and record the condition somewhat in detail, especially since they belong to the neoplasms, a group which, as our knowledge increases, is becoming more intimately associated with chronic inflammatory reaction.

In 1909 one of us (MacCarty<sup>1</sup>) included and classified the condition, reporting one case in a series of 365 gall-bladders which had been removed at operation. It was described as a part or a stage of a reaction of the tissues of the gall-bladder to one or more irritants.

In order to emphasize that pathologic conditions in the gall-bladder are actually stages of inflammatory reaction and be able more clearly to understand the possible relation of papilloma to other reactions, it seems best to re-describe the classification and terminology.

In the series of 365 gall-bladders the lesions grouped themselves in the following manner:

I. *Cholecystitis Catarrhalis Acuta*.—In this group were placed gall-bladders which retained their general normal characteristics in regard to size and color, both inside and outside, with the exception that the villi were congested, infiltrated with lymphocytes, and more prominent than normal. The lymphocytic infiltration often extended into the other layers of the wall. The condition occurred with or without stones. Attention was first drawn to this early reactive condition by the examination of excised gall-bladders which contained stones, but which grossly showed no apparent changes. Upon microscopic examination, however, the mucosa was infiltrated with lymphocytes and

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<sup>1</sup> MacCarty, W. C.: The Pathology of the Gall-bladder and Some Associated Lesions. ANN. SURG., 1910, li, 651-669.

leucocytes. The diagnosis was sometimes made during cholecystostomy by the presence of thick viscid bile, which seems to indicate hyperactivity of the glands of the mucosa and perhaps partial obstruction of the natural drainage. Other specimens in which no stones were found presented this same condition, and clinically gave a picture of cholecystitis. The stones which occurred in these cases were usually small, and it is quite possible that in some cases similar stones may have been passed through the ducts in the cases in which none were found, or the condition may have been simply the forerunner of stones. This early reaction of the mucosa was seen again in association with further changes, which constitute the second group.

II. *Cholecystitis Catarrhalis Chronica*.—These specimens varied from Group I only in degree; one portion of the gall-bladder often belonged to the first group and another portion to this group. The principal change grossly consisted of an "erosion" of the apices of the villi. They presented themselves as yellow specks scattered over the mucosa. Otherwise the mucosa appeared to be normal or congested. This condition was described as a "strawberry" gall-bladder on account of the resemblance of the yellow specks to strawberry seeds. Microscopically, one easily recognized that the epithelium of the apices of the villi was lost and replaced by scar tissue. Clinically, there was nothing to distinguish this group from Group I. It was found with or without stones.

III. *Cholecystitis Catarrhalis Papillomatosa*.—In this group there was only one specimen. One of the villi was enlarged and appeared as a papilloma. The condition was associated with stones and an acute catarrhal reaction in the mucosa. The papilloma was 2 mm. long and about 1 mm. in diameter. The cells of the epithelium covering the villi and papilloma were regular in size and shape and possessed nuclei showing no irregularities.

It is this group which forms the basis of this report because it has been so frequently found, since the original report.

IV. *Cholecystitis Papillomatosa Malignum*.—Like papillomata in other portions of the body, those in the gall-bladder undergo an irregular or perverted epithelial hyperplasia, which manifests itself in marked reduplication of the rows of epithelial cells. Upon high-power examination the cells present the cytological changes which one sees in secondary epithelial hyperplasia. Such cases have been found during exploration, at which time portions of the gall-bladder were taken for examination. This type does not occur in this series because the cases were studied at exploration of inoperable cases.

## PAPILLOMA OF THE GALL-BLADDER

V. *Cholecystitis Catarrhalis Carcinomatosa*.—In the first series of 365 gall-bladders there were three cases of cholecystitis catarrhalis chronica which were complicated by carcinoma. Since this report all specimens, from January 1, 1907 to January 1, 1915, have been studied. The complete series, inclusive of the 365 specimens already reported, consists of 2168 specimens, of which 25 definitely belonged to this group. There were knob-like outgrowths composed largely of epithelium which was in a stage of hyperplasia, differing apparently from simple hyperplasia in that the nuclei were large, irregular in shape and size, and had irregularly distributed chromatin.

There were areas, however, which were indistinguishable from normal or hyperplastic glands. The more extensive outgrowths arose from the mucosa and possessed a base not unlike that seen in the papilloma. The body of the growth is composed of masses of epithelial cells which, upon high-power examination, present extensive irregularities in the size, shape and distribution of the chromatin granules. Differentiation between this group and Group IV (*cholecystitis papillomatosa malignum*) must be made with reserve, because it is possible that the one is but a stage of the other. No specimens in the series presented sufficient evidence for grouping both conditions under one heading. Earlier stages of carcinoma of the gall-bladder must be found and studied before the life-history of the epithelium can be accurately pictured.

VI. *Cholecystitis Chronica*.—In this group was placed a condition, gradual stages of which were seen in specimens of Group II. The apparent continued desquamation of the apices of the villi is associated with proliferation of the connective tissue of the villi and submucosa. The surface, which is normally regular, contracts irregularly and leaves ridges of scar tissue. Upon microscopic examination the inner surface was seen to be void of epithelium and the mucosa was replaced by scar tissue. The process was not always complete over the whole gall-bladder, as a result of which areas of the condition described in Groups I and II were often seen. The condition occurred with or without stones. It was classified under the term *cholecystitis chronica* because the mucosa was almost completely destroyed and the process was apparently a chronic one involving the other coats of the wall.

VII. *Cholecystitis Chronica Cystica*.—A stone was frequently found lodged in the cystic duct or in the valves of the neck of the gall-bladder, thereby causing obstruction and distention of the organ. This resulted in thinning of the wall and destruction of the mucosa or flattening of the scar tissue ridges in the chronic cases.

The stone was usually firmly embedded between the valves and could not be moved in either direction. Microscopically the wall was a thin layer of connective tissue in which traces of the nuclei of the muscle-cells were sometimes found. Such a gall-bladder attained great size, and was usually the type which presents itself as a large palpable tumor.

VIII. *Cholecystitis Purulenta Necrotica*.—During any stage of inflammation, which has been described, obstruction to the cystic duct, plus a pyogenetic infection, disturbance of the circulation and multiple abscesses in the wall of the gall-bladder may occur. Such specimens were usually distended, dark blue or black, the contents pus or blood, and usually not bile-stained.

Pericholecystitis acuta and chronica were considered a sequel of any of the above-mentioned degrees of inflammation. Even in the earliest degree of cholecystitis catarrhalis acuta the process often extended to the serosa through the lymphatics, and it was not infrequent to see adhesions, usually to the omentum, duodenum, stomach and transverse colon in this stage.

Since the original report was made more gall-bladders have been removed in earlier stages of inflammatory reaction and this fact is probably responsible for the frequency of the papillomatous condition which has been recently found.

Out of 2168 gall-bladders which have been examined between January 1, 1907 and January 1, 1915, 85 specimens have been found in which one or more papillomata have been seen (Figs. 1-7).

In all cases the mucosa was intact. The papillomata vary from twice to 5 or 6 times the length of normal villi. They are usually pedunculated, frequently racemose, and usually white or yellow. They appear in any portion of the organ, being confined neither to the neck nor the fundus.

Upon microscopic section they appear to be hypertrophic villi, the tissue elements of which present an hyperplastic condition. The connective tissue and glandular tissues are greatly increased, the latter being so distorted that sections cut the glands in many different planes. The epithelium of the glands is hypertrophic and occasionally hyperplastic, and practically always completely covers the growth.

In the stroma one often finds large round or oval cells which contain fat (Figs. 8 and 10) or some fatty substance, this condition probably being responsible for the yellowish gross appearance of the growths.

In no case were there any signs of early carcinoma, although simi-



FIG. 1.



FIG. 2.

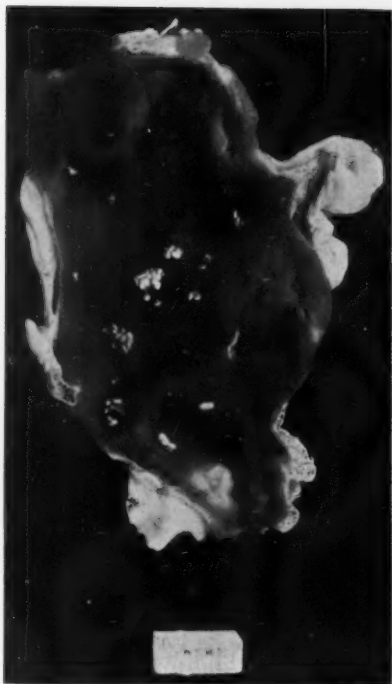


FIG. 4.



FIG. 3.



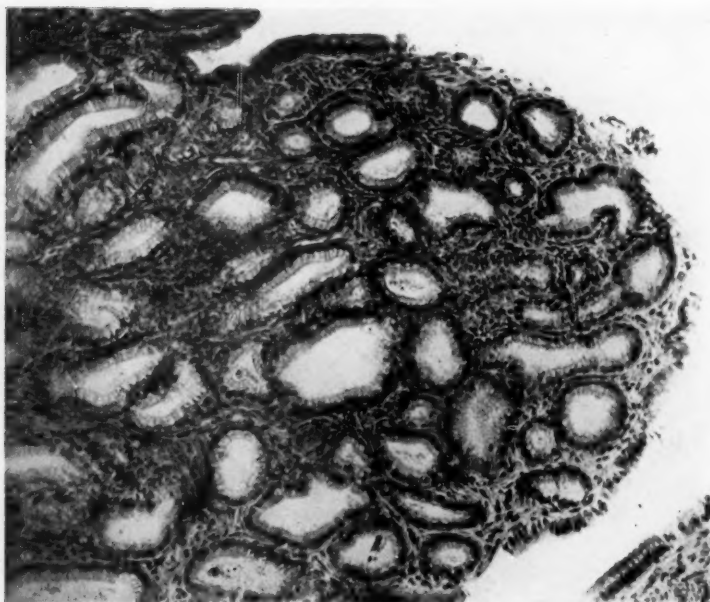
FIGS. 1, 2, 3, and 4.—A 97358, A 65036, A 78954 and A 99169. Gall-bladders which contain various sized papillomata in different positions, ranging from the fundus to the neck.



FIG. 5.



FIG. 6.



FIGS. 5 and 6.—A 96563 and A 98808. Low-power sections showing the papillomatous outgrowths from the mucosa.

FIG. 7.

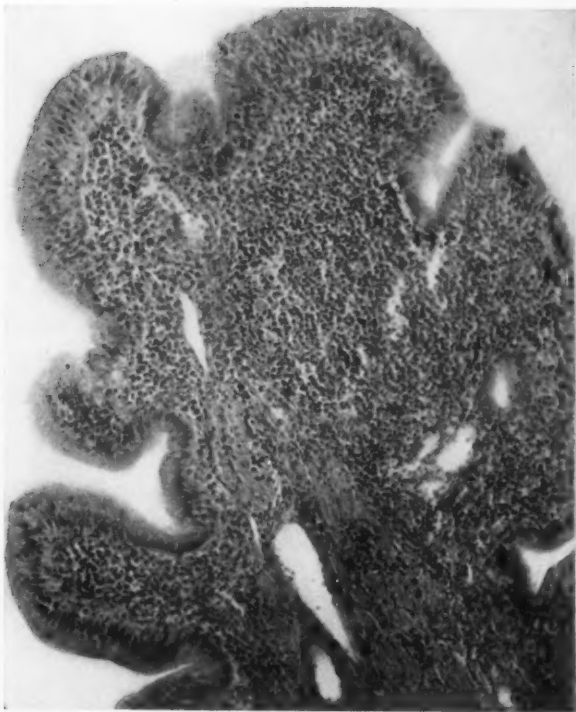


FIG. 8.

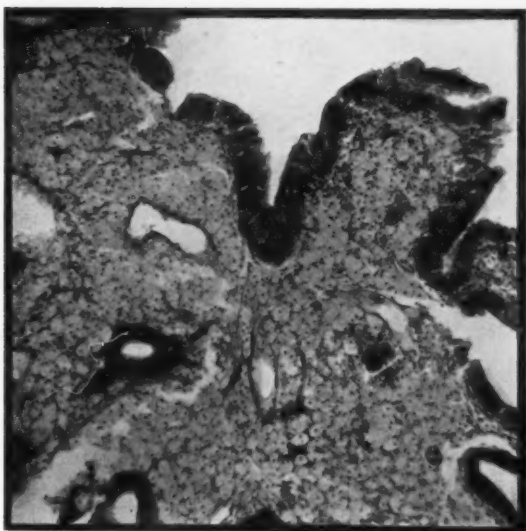
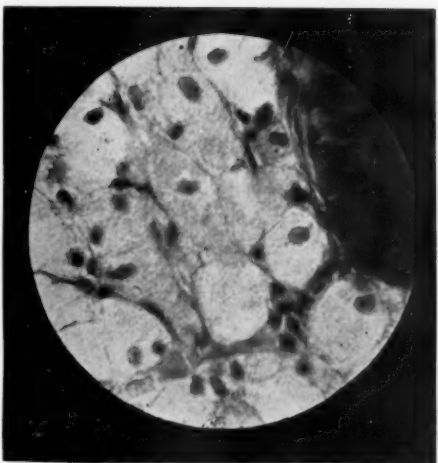


FIG. 9.



FIG. 10.



FIGS. 7, 8, 9, and 10.—A 96563, A 78954, A 99469 and A 78954. Higher magnifications of the epithelium and stroma.



## PAPILLOMA OF THE GALL-BLADDER

lar hypertrophic conditions of the villi have been seen in association with carcinomatous outgrowths of the gall-bladder.

The condition occurred in *cholecystitis catarrhalis acuta*, *cholecystitis catarrhalis chronica*, *cholecystitis catarrhalis cystica*, *cholecystitis catarrhalis carcinomatosa*, and *cholecystitis catarrhalis purulenta necrotica*.

It occurred with and without the association of stones and was more frequent in females than males, probably due to the fact that more gall-bladders were removed in females.

The writers take the liberty of reporting these cases in order to stimulate observers to watch for the association of the condition with malignant changes in the mucosa, since it is associated with chronic inflammation and has been associated with late carcinoma.

It is quite possible, in the light of recently discovered facts relative to the stages of epithelial hyperplasia from chronic irritation, that these fibro-epithelial proliferations might also present the stages which are apparently a part of a cytological reaction, which ends in a malignant condition.

## OCCULT STRANGULATED INGUINAL HERNIA; SPONTANEOUS REDUCTION "EN MASSE"

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THE strangulation of an inguinal hernia offers, as a rule, no opportunity for niceties of diagnosis and treatment, but in the two cases cited herein all the symptoms and signs of this condition were present, with the exception of a palpable tumor, either in the canal or in the scrotum.

In one of the Arris and Gale lectures for 1900, Moynihan describes a number of unusual herniæ occurring in the inguinal region and among which is noted a type that he calls "reduction *en masse*," to differentiate it from the group of properitoneal herniæ. The true inguinoproperitoneal hernia must have (a) a hernial sac having two distinct loculi; (b) the inner loculus lying between the peritoneum and the fascia transversalis; (c) the outer loculus lying in the inguinal canal or, in rarer instances, between the layers of the abdominal wall; (d) both loculi opening into the abdomen by a single orifice, the ostium abdominale.

Another important feature of this type of case is the association with a maldescended testis; 23 in a series of 59 recorded showed this defect; the coincidence being attributed to the fact that the cryptorchid interfered with the usual descent of the accompanying sac.

Moynihan insists that the term "reduction *en masse*" should be reserved for those cases that have *the mutual relation of the sac and its contents undisturbed*, where the entire mass is found behind the muscles and fascia, that is to say, not in the canal.

In searching the museums of London for specimens of interstitial and properitoneal herniæ, he found that most of the preparations of this class, *i.e.*, properitoneal hernia, were labelled as having been reduced *en masse*, which he regards as an error, and he goes on to state that true cases of complete reduction are rare indeed, and in the cases observed the hernia is of long duration with loosening of the sac from the surrounding structures and usually the result of long-continued and ill-advised taxis. Herniæ of this variety were first described by Saviard and later by Le Dran, Lafaye and Richter.



## OCCULT STRANGULATED INGUINAL HERNIA

Rokitansky a good many years ago described a number of pouches in the peritoneum of the inguinal region, and herniæ into these have been described by Brunner, Havage, Englesch, Wagner and others. The question as to whether or not these pouches have any etiological bearing on this type of case is at present merely problematical. These fossæ may be demonstrated easily by placing the subject face downward on the dissecting table and working from before backward.

Eppinger has shown that the inguinal canal may be arbitrarily divided into three portions:

1. Extending from the anatomical internal ring to the point where the infundibuliform fascia enters the transversus abdominis. In this portion the interspace between the peritoneum and the fascia transversalis is filled with very loose and lax areolar tissue containing fat. The fascia transversalis is much more firmly attached to the transversus than to the peritoneum.

2. This portion is surrounded by the transversus and the internal oblique muscles, closely embraced by them and approximately 10-12 mm. in length.

3. Extending from the internal oblique to the opening in the external oblique. In this portion the surroundings are again lax and soft, yielding and distensile. In the first and third portions the adventitious sacs are most commonly found, the second portion is more rarely the site of a diverticulum from the sac.

While the reduction of a hernia in the inguinal canal *en masse* naturally presupposes the application of taxis, still the foregoing may in a measure explain the spontaneous reduction of the sac and its contents in the following cases. With a sac with a narrow neck and placed in a canal that in the first and third portions is naturally lax and yielding and the association with a deficient second portion, one can readily see that a reduction *en masse* can take place spontaneously, all the more so if the sac is short and some of the peritoneum of the parietes is drawn into the canal where by its own elasticity it acts as a natural tractor and exerts a pull from within. As the sac at operation lay between the peritoneum and the transversalis fascia, the only evidence we have that the sac was ever in the canal is the patient's history, the first patient having actually worn a truss and the second giving a distinct story of a lump in the groin for two weeks; and in both cases the sac was large enough to have a portion of small bowel caught in the constricted neck.

CASE I.—A. B., No. 42,982, aged sixty-three, was admitted to Lebanon Hospital in the service of Dr. Parker Syms, on November 7, 1913, with the following history: Has had a bulge in the right groin for the last four years and for which he wore a truss. Three days ago he was seized with pain in this region which was localized at first, but later spread over the entire abdomen. Began to vomit with the onset of this pain and continued to do so up to the time of admission. Bowels were constipated. Never had a similar attack. His physician made a diagnosis of intestinal obstruction and advised his removal to the hospital for operation.

*Physical Examination.*—The patient looks acutely ill and his features are drawn, his whole appearance denoting the fact that he has recently lost a large amount of fluid. Chest shows signs of an old emphysema. Abdomen is much distended and very tender to the touch, especially over the right Poupart's ligament, where there is distinct rigidity. His scrotum is devoid of a sac and the finger in the canal elicits nothing abnormal in the way of contents or impulse on coughing. Pulse 100; respiration 30; temperature 98°.

*Operation* (November 7).—Taken to the operating room as soon as preparations were complete. Low right rectus incision just above Poupart's ligament under novocaine 1-200. On opening the peritoneum a quantity of serosanguineous fluid escaped and a mass was found at the site of the internal ring; further manipulations were precluded by the patient straining so the local infiltration was supplemented by ether by the drop method. A loop of distended bowel led into this mass and a loop of collapsed bowel emanated from it. The ring of peritoneum that caused the actual constriction was incised, liberating from the sac about ten inches of very doubtful looking gut, the peritoneum covering this section of bowel was granular and very dusky, but after some "coaxing" with hot towels the color returned somewhat to normal but not sufficiently to permit it to be returned permanently to the abdomen. A suture was passed through the mesentery and the bowel replaced temporarily within the abdomen subject to further inspection. The sac was explored and was found to be unilocular and gangrenous, and was removed by transfixing the base of the sac within the abdomen, ligating the neck and ablation.

The questionable bowel was now withdrawn from the abdomen by means of the suture through the mesentery and was still found to be granular in appearance in certain small areas. The condition of the patient precluded any radical procedure, so this segment of bowel was carefully surrounded by several cigarette drains and some loose gauze and replaced just below the incision,

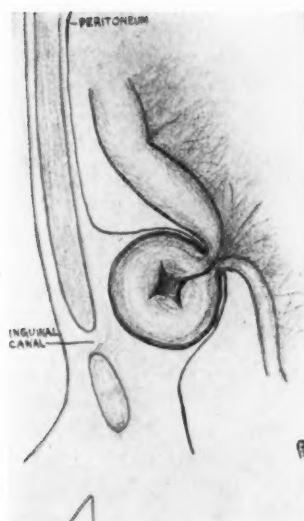


FIG. 1.—Cross-section at site of internal ring (semidiagrammatic).



## OCCULT STRANGULATED INGUINAL HERNIA

which was partly closed with several sutures of silkworm gut. On the fourth day there was some discharge of intestinal contents through the wound, but this ceased spontaneously in about a week. Patient discharged with a small granulating wound on November 26, future dressings being done by his own physician. Subsequent report a few weeks later showed the wound healed and the patient back at work.

CASE II.—J. R., No. 39,863, aged thirty-three, was admitted to Lebanon Hospital in the service of Dr. Parker Syms, on January 22, 1913, with the following history: Two weeks before admission while at work he lifted a heavy weight and had a sudden attack of pain in his right groin. This pain, he avers, was coincident with the appearance of a "swelling" in the location of the external ring. When he first noticed this it was about the size of a cherry but gradually became larger and more painful, less so at night. He says that he was always able to reduce it but with some discomfort, with the exception of one occasion two days before admission, when he had his physician do this for him. Was extremely perturbed over this and had very little appetite. Bowels constipated. His chief complaint on admission to the hospital was pain in the abdomen, chiefly in the region above the right Poupart's ligament. Pulse 80; temperature 99°; respiration 20.

*Examination on Admission.*—Showed nothing abnormal except some tenderness at the site mentioned above. In view of the fact, however, that he had had a mass reduced by his physician two days previously, he was kept in the ward, up and about, with the idea of demonstrating a hernia.

Two days later his pain returned with increased intensity and he vomited several times. Examination at this time revealed nothing except the fact that he had more marked tenderness in the lower part of the right side of his abdomen. The external ring was not excessively patulous nor was there any suggestion of any sac and its contents in the canal, no impulse on coughing.

*Operation* (January 24, 1913).—Low right rectus incision; with the opening of the peritoneum there was an escape of sero-sanguineous fluid. A distended loop of bowel led into a small opening at about the site of the internal ring, from which was gently removed a loop of bowel about three inches long. This was slightly dusky in color, but soon returned to normal. The small opening led into a small pouch which was obliterated from within by a few sutures of Pagenstecher. Abdomen closed in layers without drainage. Discharged cured on February 22.

Both of the cases reported above had symptoms of an intestinal obstruction, both gave a history of having had a hernial protrusion, one



only a few weeks, while the other had it four years and wore a truss; in neither of these cases was any attempts at forcible reduction made, and yet at operation the sac and its contents was found behind the muscles of the abdominal wall and in front of the peritoneum. The impression that both of these cases gave one was that of a strangulated hernia, but lacking the all-important presence of the sac in the canal or in the scrotum, but the fact that they both gave evidences of having had a hernia at some previous time, coupled with the fact that the symptoms pointed to the corresponding Poupart's ligament, was enough to lead one to believe, or at least suspect, that the condition was one of a strangulated hernia of unusual type.

The incisions through the lower right rectus were predetermined with the object in view of coming down on the seat of trouble at once to ascertain the true state of affairs, rather than working through the somewhat restricted field of a herniotomy incision with the possibility of having to make another opening above as would have been necessary in the first case. The idea of repairing hernial protrusions from the peritoneal side of the abdominal wall is nothing new, Beckman of the Mayo clinic having called attention to this fact a few years ago. Naturally the method here employed was not the method of choice, but in the presence of an unusual condition was therefore adopted.

According to the classification adopted by Moynihan and Coley, despite the fact that the sac was found in the properitoneal space, these cases cannot be listed as properitoneal herniæ because of the unilocular sacs; but the presence of the sac and its contents undisturbed, notwithstanding the absence of forcible taxis, these cases must therefore come under the heading of "reduction *en masse*," spontaneous in origin and occult in nature.

## THE TREATMENT OF BENIGN PAPILLOMATA OF THE URINARY BLADDER WITH HIGH FREQUENCY CURRENTS\*

BY EDWIN BEER, M.D.

OF NEW YORK

ALTHOUGH this new method of destroying vesical tumors is in use only a short time (1910), we have had sufficient experience with it to enable us to decide when and how it should be employed. Papers have been published bearing on this subject in America, Germany, France, Italy, Austria, Belgium, Holland, England and other countries. Almost all surgeons report their experiences in a small series of cases. In America a large number of papers have appeared, covering a goodly number of cases. Practically every surgeon has reported favorably, bearing out the experience that I have had in my own cases.

It is no longer necessary to work with the more complicated operating cystoscope to destroy these papillomata, though it is necessary to use such instruments as Buerger's forceps or Young's rongeur to obtain specimens from the growths for microscopic study. The importance of this procedure I have repeatedly emphasized, as malignant growths do not respond to the treatment.<sup>1</sup> In the 84 cases of neoplasm of the bladder, on which I have notes, 51 were examined microscopically, and in many of these the microscope verified my suspicion of malignancy, while in a smaller series it upset the clinical impression obtained by means of cystoscopic examination. Occasionally the microscope may be misleading, as specimens taken from the surface may be benign papilloma while deeper parts may be malignant. After burning off such surface growth, specimens from the deeper growth can readily be obtained, and, if the operator is still suspicious of the malignancy of the growth, further specimens must be obtained and studied. All this entails but slight delay as specimens are readily obtained at the first or second cystoscopy. It cannot be denied that despite all this care mistakes in diagnosis will occur, though I feel confident that such mistakes will be rare, if one carefully weighs the evidence obtained by palpation, cystoscopy (including the response to the high frequency cauterization), and the microscopic study.

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\* Read before the New York Surgical Society, February 10, 1915.

<sup>1</sup> Beer, Edwin: *Journal of the American Medical Association*, May 28, 1910; *ANNALS OF SURGERY*, August, 1911; *Zeitschrift f. Urologie*, 1912.

In America the therapy is called by various names. I prefer to call it high frequency cauterization, till we find out exactly how the effects are produced. Some call it "sparking," translated into the French by Heitz-Boyer as "*etincilage*," and others incorrectly call it fulguration. In Germany, where the bipolar, d'Arsonval current is most generally used, owing to the fact that they have neither the proper electrodes to carry the Oudin current nor (apparently) the proper apparatus for producing it, the method has been termed "electro-coagulation." In France both electro-coagulation and *etincilage* are applied to the method under discussion.

There appears to be a slight difference in the way the Oudin and the d'Arsonval currents act, when tested on raw beef outside of animal body. The Oudin or unipolar current produces a more marked focal action at the point of application of the electrode, and a less marked though distinct distant action, apparently a cauterization and coagula-

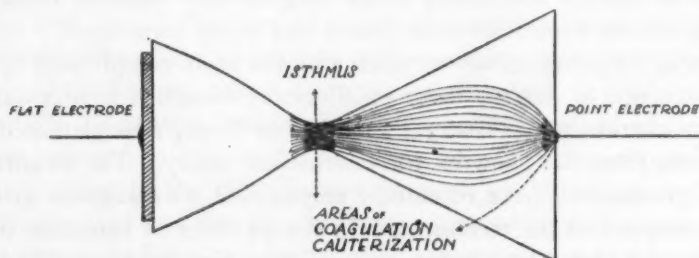


FIG. 1.—D'Arsonval or bipolar current.

tion. There is also what looks like an explosive action, as pieces are torn or broken off from the growth. On the other hand, the bipolar current has none or very slight explosive or disruptive action. Its local action is less and its distant action, coagulation by heat, is more marked. By virtue of this, which makes its action less controllable, I believe it inferior to the unipolar or Oudin current for the purpose of destroying papillomata. In view of this distant coagulation and the more extensive sloughing induced, the occasional hemorrhages following the use of the bipolar current seem to be readily explained. These differences in the actions of the two types of high frequency currents are readily demonstrated on a raw piece of beef which has been cut, as indicated in the accompanying illustrations (Figs. 1 and 2).

The more active concentration of the bipolar current at the isthmus, or narrowest point, would appear *a priori* to be a distinct advantage in destroying the tumor's pedicle at the very first sitting. If these growths were pedunculated and floating freely in the lumen and in contact with

## HIGH FREQUENCY CURRENT FOR BLADDER PAPILLOMATA

the bladder wall at only one place, the pedicle, theoretically the bipolar current would seem to have a distinct advantage. But as the growths are usually in contact at numerous points, this theoretical advantage, based on the concentration of the waves of current at the narrowest point, cannot regularly obtain. Moreover, those who make use of only the bipolar current are frequently annoyed by the fact that the dead tumor remains attached by its more or less dead pedicle for a very long time. The Oudin current, by virtue of its explosive action, in a great measure prevents this. Because of these considerations, because of its less marked distant action, and its more perfect control, I use the Oudin current<sup>2</sup> much more frequently than the d'Arsonval.

Further experience may demonstrate that a combination of both currents—first, a brief bipolar treatment and subsequently the use of the unipolar current—may give more rapid results; such a preliminary d'Arsonvalization followed by an Oudinization would combine the virtues of both.

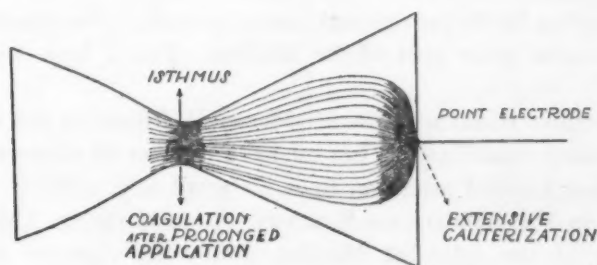


FIG. 2.—Oudin or unipolar current.

In the literature, one reads occasionally that this method of treatment should not be used in large papillomata. I believe this is a mistake and that size presents no limitations to this method, as I find that I can employ it satisfactorily in even the largest growths. The largest growth that I have seen, surely as large as a good-sized orange, I was able to destroy in six sittings. At the second sitting I was able to obtain, through the sheath of the cystoscope, enough tumor tissue to fill a 60 c.c. bottle. Consequently, from my personal experience, I would emphasize the point that size is no contra-indication to the use of the therapy under discussion. On the other hand, tumors situated at the neck of the bladder, especially those that bleed profusely when injured by the introduction of the cystoscope, will usually have to be operated

<sup>2</sup> As seen in the specimens it can produce a very similar distant action, to that of the bipolar current, provided the applications are very prolonged.



upon, preferably suprapubic cystotomy and Paquelinization. This will give relief in apparently hopeless cases. Patients that are intolerant of cystoscopy and growths that are inaccessible, hidden in diverticulæ or pouches, will also require operative interference. Whether the new instrument of Lohnstein, for retrograde applications, will help us in the first group of cases, the future will demonstrate.

Another point frequently encountered in the literature of this subject is a certain scepticism as to the end results. It may be too early to speak of these, but from my own experience I feel certain that these cases can be definitely cured by this method. Only recently I have re-examined my earliest cases, 4 years after destruction of the growths, and there was no sign of recurrence. Another case 3½ years after completion of the treatment is also absolutely well. By recystoscopy every 3-4 months one can control these cases most satisfactorily, and I believe that if there is no sign of recurrence *in loco* at the very first re-examination, there is very little reason to apprehend a local recurrence or a recrudescence of the original tumor. In some cases, the same cause that led to the original tumors or tumor may produce a new growth in some other part of the bladder. This I have seen several times.

The peculiar reaction in the bladder wall, following the use of the high frequency cauterization, has misled a number of observers despite the fact that I called attention to it, in word and picture, some four years ago in the ANNALS OF SURGERY, August, 1911. This peculiar thickening of the adjacent bladder, following vigorous treatment, suggests an infiltration of a malignant neoplasm. Barney has excised such an area, thinking it was carcinoma, and histologically no sign of neoplasm was visible.

In closing, I must again emphasize the importance of obtaining specimens for microscopic study, as all tumors that are malignant should be excluded from this method of treatment. I usually treat these cases at the first cystoscopy, unless they are frankly carcinoma; and in case I do not see extensive destruction, *i.e.*, good response to the previous treatment, I excise several pieces of the growth, at the second cystoscopy. Cases that are not definitely benign and all malign cases are treated by wide excision.

**Conclusions.**—(1) Results with high frequency cauterization have been satisfactory.

(2) By careful weighing of the evidence obtained by cystoscopy, response to cauterization, palpation and microscopic study of excised and voided specimens, malignant papillomata can usually be recognized



#### HIGH FREQUENCY CURRENT FOR BLADDER PAPILLOMATA

- (3) All malignant cases should be excluded from this therapy.
- (4) The Oudin current is to be preferred, at the present time, as its effects are more readily controlled, and it has certain other definite advantages over the d'Arsonval current.
- (5) The large size of a papilloma is no contra-indication to the use of this therapy.
- (6) Inaccessibility, traumatic severe hemorrhage due to the introduction of the cystoscope, intolerance of the patient, and malignancy are the important contra-indications.
- (7) The end results are highly satisfactory. My original cases are well over 4 years.

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

*Stated Meeting, Held February 10, 1915*

The President, DR. FREDERIC KAMMERER, in the Chair

### OSTEOPLASTIC REPAIR OF SKULL DEFECT

DR. ROBERT T. MORRIS presented a man, twenty-five years of age, who had received a compound fracture of the skull in the right upper temporal region seventeen years previously. There resulted an area about the size of a silver half dollar which was covered over with skin and fibrous tissue only, and pulsations of the brain could be felt beneath. There was some loss of power of the left hand and an aura began from the left hand fourteen years ago, followed by epileptic seizures. These had continued for fourteen years, the patient sometimes having as many as five attacks in the course of a week, sometimes two in a single night.

The tissues in the area of defect were dissected free, dural adhesions separated and the scar tissue excised from the cortical brain area. Cargile membrane was introduced for the purpose of preventing recurrence of adhesions and an osteoplastic graft from the tibia was placed in the cranial opening.

The patient has had no epileptic attacks since the operation, about nine months having elapsed.

The point of special interest was the firmness of the osteoplastic graft. It seemed almost as though the patient had bony union. Even though osteoblasts may not construct new bone from the cranium or pericranium, it is possible that new bone cells from the graft had made firm union with cranial bone.

### FRACTURE OF THE LOWER END OF THE RADIUS AND HEAD OF THE ULNA WITH ANTERIOR DISPLACEMENT OF THE CARPAL FRAGMENTS

DR. J. M. HITZROT presented a patient brought to the New York Hospital by Dr. J. H. P. Hodgson, August 1, 1914, with a history of having been thrown from a horse about ten hours before admission. The patient fell with the left hand *flexed* under her and when picked up

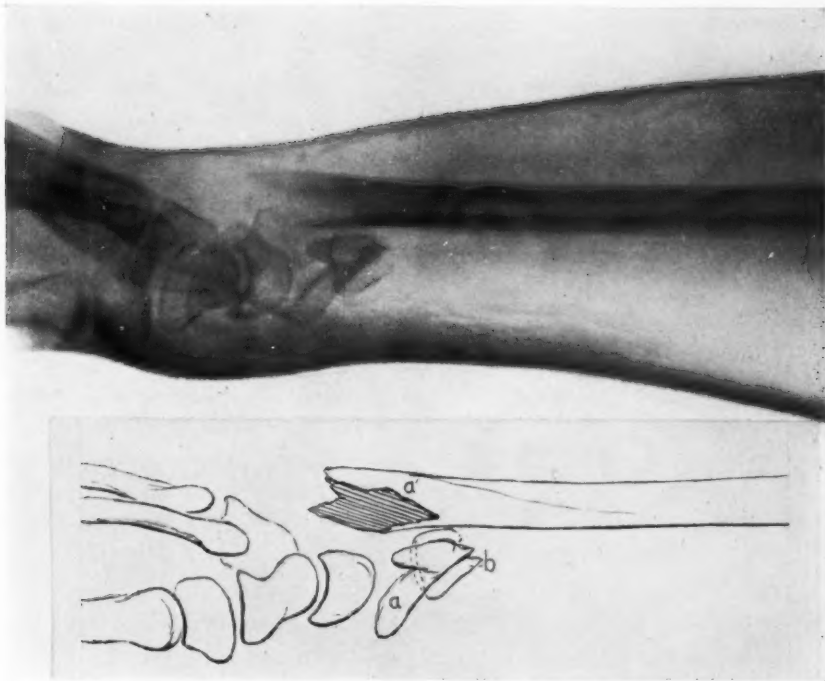


FIG. 1.—Fracture of the lower end of the radius and ulna with anterior displacement of the lower fragments. *a*, lower fragment of the radius; *a'*, fracture surface of lower end of shaft of radius; *b*, lower fragment of ulna.



## FRACTURE OF RADIUS AND ULNA

complained of severe pain at the left wrist and elbow at which joints motion was impossible. The wrist fracture was "reduced" (?) by a doctor who saw her, the arm put in splints, and she was sent to the city for the elbow lesion. Dr. Hodgson brought her to the hospital at once upon seeing her.

The patient was anesthetized, the arm examined and an anterior displacement of the head of the radius found. There was also a fracture of the lower end of the radius and of the styloid and head of the ulna with displacement of the lower fragments forward and toward the radial side. The lower end of the upper radial fragment could be readily felt on the posterior surface of the wrist-joint, while the lower end of the upper ulnar fragment was readily seen and palpable on the posterior aspect of the wrist. The deformity was unlike the so-called silver fork deformity in that the curve between the handle and the prongs of the fork was just the reverse of that seen in the typical deformity of Colles' fracture. Roberts has described this as the gardener's spade deformity.

It was found impossible to correct the fracture at the lower end of the bone by manipulation. An X-ray (Fig. 1) was taken which showed a fracture of the lower end of the radius and the head of the ulna with anterior displacement of the lower fragments and posterior displacement of the upper fragments.

In the extended position traction downward upon the arm with pressure over the radial head brought about the reduction of the head of the radius without any difficulty, and no further injury at or near the elbow was discoverable. This was subsequently proven by the X-ray, which showed complete reduction of the radius.

On August 4 a three-inch incision was made over the dorsum of the wrist. The lower end of the upper radial fragment had perforated the annular ligament and its jagged end was caught in the subcutaneous fat. The whole of the extensor group of tendons was found to have dropped between the two radial fragments. The tendons were freed and retracted and the two radial and ulnar ends brought into perfect apposition. The tendons were replaced, and their sheaths and the annular ligament closed loosely with plain catgut, the skin with horse hair, and moulded anterior and posterior plaster splints applied. The patient's convalescence was uninterrupted. An X-ray picture after the reduction showed reposition almost perfect. Baking and massage were begun on the twelfth day after operation, and movements of the fingers encouraged from the start. The splints were removed on the thirty-first day and the patient regained complete use of the arm at the end of twelve weeks.



## NEW YORK SURGICAL SOCIETY

At the present time there is practically complete flexion and extension at the wrist. There is some limitation of supination and the left arm cannot be brought into quite as complete extension at the elbow as the right, although the degree lost is too small to measure.

Dr. Hitzrot called attention to the fact that fractures of the above type were undoubtedly very rare, and that in so far as he was able to ascertain, this was the only case of this type at the New York Hospital since the advent of the X-ray. The old pathological cabinet at the New York Hospital contained two specimens of a similar injury: (1) a dissected specimen of a fracture at the lower end of the radius with displacement of the distal fragment, and coincident backward dislocation of the head of the ulna; and (2) a plaster cast of the same form of fracture.

Callender (*St. Bartholomew's Hospital Reports*, 1865, vol. i, p. 289) reports a similar case due to forced flexion in which reduction was impossible. Ten months later the deformity persisted with exaggeration of movements in flexion with limitation of extension to a straight line and good rotation.

Dr. J. B. Roberts, in a paper read before the American Surgical Association upon fracture of the lower end of the radius with anterior displacement of the carpal fragment (*Trans. Amer. Surg. Asso.*, 1896, vol. xiv, p. 611) reports 4 personal cases of this injury, and 9 cases obtained by personal correspondence, and 9 other cases collected from the literature, and 31 cases preserved in various museums, all of which are similar in type, but not identical with the case presented here.

Roberts states he has seen no case in its recent state. The functional result in his personal cases in which it was stated there was present limitation in extension and flexion with pronation almost completely lost (case two) with great limitation in the use of the fingers and (case one) with perfect use of the wrist and fingers.

In the *International Clinics*, vol. i, Series vii, 1897, p. 223, Roberts mentions another case of this type with reduction and subsequent functional recovery.

### BONE CYST; PATHOLOGICAL FRACTURE OF HUMERUS SHAFT

DR. J. M. HITZROT presented a man who was admitted to the First Surgical (Cornell) Division of the New York Hospital on May 20, 1914, with a history of having fallen through a door and broken his left arm six days previously. There was no previous history of pain or difficulty with the arm and his past history was in every way negative.

When admitted there was a fracture of the left arm about the

## BONE CYST

middle of the shaft with crepitus, etc. There was very little swelling of the arm and no ecchymosis. X-ray pictures taken May 20, 1914, showed a bone cyst of the humerus with a pathological fracture through the thinned-out cortical bone and with little displacement, except that due to angulation anteroposteriorly.

On May 23 a long incision was made over the outer lateral aspect of the arm down to the line of fracture, which was found to be a fracture through a bone cyst with extensive fragmentation of the walls of the cyst. About the site of the fracture and among the bone fragments there was a mass of viscid gummy material which extended from the medullary cavity into the surrounding musculature. The adjacent muscle tissue seemed to be infiltrated by a mass of more or less homogeneous cartilage-like material. Frozen sections made at the time from the viscid material obtained from the medulla were reported as a myxochondrosarcoma. The infiltrated muscle tissue and the adjacent bone were widely removed, leaving a defect of about three inches between the two bone ends.

In view of the doubtful pathology of these lesions in general and in spite of the pathological report, it seemed wisest to first try conservative measures before resorting to an amputation. With the Kenyon saw two slots were then cut in the upper and lower ends of the bone along the same longitudinal axis. A bone graft similar to the above described slots and long enough (eight inches) to maintain the length of the bone was then cut from the left tibia and with its periosteum attached was transplanted into these slots and fastened there by pressing it firmly home and by two stout kangaroo sutures wrapped about the bone at each end. The periosteum was then stitched to the periosteum of the shaft and the wound closed loosely with plain catgut and silkworm-gut in the skin without drainage, with an alcohol thymol dressing, and the arm put up in Hitzrot's modification of the moulded splints described by Stimson for fractures of the shaft of the humerus. Eight weeks after the operation the union was solid and the splints were removed, and at the end of twelve weeks complete use of the arm was permitted.

The X-ray plates taken at frequent intervals show a gradual consolidation of the callus which, as is usual, is most marked on the concave side, and the bone graft is still present in the last picture taken eight months after the operation. There is as yet no indication of tumor growth.

Elmslie of London (*Brit. Jour. Surg.*, 1914, vol. ii, p. 17) reviews the subject of bone cysts and gives all the various explanations of their

## NEW YORK SURGICAL SOCIETY

formation and shows X-ray photographs of a number of cases similar to this one. The large amount of cartilage would suggest that in this case the cyst might resemble Virchow's classical case of cyst formation in an enchondroma. Elmslie's cases were cured by simply curetting away the tumor material, after which the fractures healed. There were no giant-cells in this case and there was no evidence of old blood to place the case in the category recently called hemorrhagic osteomyelitis by Barrie (*Surg., Gyn. and Obstet.*, July, 1914, p. 42) with cyst formation.

There was no evidence of any other bone cysts in the patient.

DR. CHARLES H. PECK reported having had a case of this type of bone cyst of the humerus which had been fractured twice, once in 1911, again two years later. Recently the patient had received an injury to the shoulder. The cyst was quite long, occupying one-quarter, at least, of the shaft of the humerus. Above it there was apparently normal bone, one and a half to two inches, between the cyst and the upper epiphysis. There was at present no solution of continuity. Dr. Peck asked Dr. Hitzrot what the latter would consider the proper treatment in such a case. Elmslie considered most of these cysts very similar in type, and all benign. He (Elmslie) advised opening and scraping the cyst, but in a number of his cases further X-ray examination showed that re-formation of the cyst had occurred. In other words, the cases were not entirely cured by this method of treatment. The speaker wondered if it would not be better to do osteotomy.

DR. HITZROT said this was the only case in which he had attempted the bone-graft method. He had had one case in which he scraped out the cyst, according to Elmslie's suggestion, but the patient dropped out of sight and he did not know the final result. In the case reported there was no re-formation of the lesion in the area occupied by the original cyst. The graft showed no cyst formation; the new formation, therefore, must have come from the surrounding tissue. Answering Dr. Peck's question, he thought it decidedly best, in the event of re-fracture, to entirely remove the part involved and resort to the bone-graft method.

### FRACTURE OF THE HEAD OF THE HUMERUS

DR. J. M. HITZROT presented a man, aged fifty-one, who had fallen down a hatchway three weeks previous to admission, April 6, 1914. In falling the patient landed on the point of his left shoulder. The shoulder became swollen and the disability which was not marked for the first few days gradually increased up to the time he presented

## ULCER OF THE STOMACH

himself for examination, when he was unable to move the shoulder in any direction without pain. All motion in every direction was limited to the barest possible amount and such abduction as was possible was due to movement of the scapula.

A skiagraph showed a fracture which, before operation, was interpreted as a fracture of the greater tuberosity with comminution of the fragments. One of the fragments was seen to be displaced into the subacromial space, and because of its presence there, an operation was deemed advisable.

April 8: A three and one-half inch anterior incision was made, splitting the anterior fibres of the deltoid. The fragment seen in the X-ray lay in the subacromial bursa which was markedly injected and plastered together by numerous veil-like adhesions. These were broken up and the fragments which were still adherent to the bone above the attachment of the supraspinatus tendon were cut away. A small rent was then found in the joint capsule just internal to the attachment of the above-mentioned fragment. This was enlarged and the joint found slightly distended by a blood-tinged, viscid fluid. Extending into the head there was a long fissure which at the capsular attachment broke into a number of irregular lines which separated a number of small fragments of bone and cartilage from the articular surface of the bone. All these last mentioned fragments were within the joint. These were removed and the joint washed out with saline solution, a small rubber drain placed in the subacromial bursa, the incision closed with plain catgut, and the muscle and skin closed in layers with plain catgut, with silkworm-gut in the skin.

Baking was begun on the third day after the operation, and massage and passive movements on the fifth day after operation. The motion increased and was much less painful than before operation. The drain was removed on the third day. Voluntary motions such as are recommended for surgical neck fractures were encouraged. At the end of ten weeks abduction to beyond a right angle and one-half normal external rotation was possible without pain; and at present there is only limited motion in forced abduction beyond the horizontal and in extreme external rotation. Curiously enough, internal rotation remained limited for a longer period than external rotation, and pain on internal rotation was present up to the fifth month. All pain had now disappeared.

## ULCER OF THE STOMACH; RESECTION IN CONTINUITY

DR. GEORGE WOOLSEY presented a man, aged thirty-eight, who was admitted to Bellevue Hospital on December 23, 1914, complaining



chiefly of epigastric pain and vomiting, with a previous history of a similar attack about a year before, prior to which time he had never been sick. The present illness began about a week before, with griping pain and then vomiting about an hour after breakfast. The patient then felt hungry and thereafter vomited after eating or drinking anything. Pain in the epigastrium was more or less continuous, and, on December 24, he had typical coffee-ground vomitus. After rest in bed the vomiting ceased and there was little or no pain. Blood test showed hæmoglobin 75 per cent.; Wassermann, 4 units, positive. Examination showed cardiac arrhythmia (luectic). X-ray showed ulcer of lesser curvature, no pyloric stenosis. Free hydrochloric acid .031.

Upon operation, January 2, 1915, a moderately indurated ulcer, the size of a half dollar, was found on the lesser curvature, three inches or more from the pylorus. Slight glandular enlargement along both curvatures. Mesogastric resection, including ulcer. There was slight difficulty in suturing at the lesser curvature; otherwise operation was simple and easy. After operation there was no pain and no vomiting. The only complaint was hunger, and the patient was kept on a strict diet with addition of alkalies for two and a half weeks. In the twenty days prior to the date of the meeting he gained twenty-four pounds. Pathological report showed gastric ulcer with no evidence of carcinoma. X-ray after operation shows the pyloric end as a teat-like projection from the rest of the stomach. Though it lies a little to the left of the median line, it is probably foreshortened, as at least three inches of the pyloric end was left.

This case is the one referred to in the discussion on Dr. Peck's paper at a previous meeting, and is shown on account of the comparative ease and simplicity of the method, and the smoothness of the post-operative course. Dr. Woolsey mentioned the fact that if a V-shaped excision of an ulcer in this position was made the operation might prove difficult, and the stomach likely to be distorted into a water-trap stomach, and that in his experience it was necessary to add to the excision a gastro-enterostomy in order to obtain a good functional result.

In this case the stomach emptied itself completely in six hours; in fact the emptying was more prompt than normal, judging from the advanced position of the bismuth in the colon. Pylorospasm is prevented, for most if not all of the nerves passing to the pylorus are divided in the resection. This operation gives better security against subsequent complications than any other operation for ulcers in this situation.



## RESECTION OF SIGMOID FOR GANGRENE

DR. WILLIAM A. DOWNES called attention to Von Eiselberg's report of 18 cases of transverse resection of the stomach without mortality. This author says in properly selected cases no other type of operation seemed to him to be as satisfactory. Dr. Downes had had two cases in which he operated by this method, in which results, as shown by the X-ray, were very satisfactory. There was no atrophy or other abnormal condition at the pylorus. He considered gastroplastic operations on the lesser curvature very unsatisfactory. He mentioned one of his cases in which the stomach had become fixed posteriorly to the pancreas, the patient suffering a great deal of pain. Complete resection was preferable.

DR. FREDERIC KAMMERER thought a contraction at the point of resection, resulting in hour-glass formation, was not as likely to occur after a V-shaped excision along the lesser curvature as after a complete resection in continuity. The less satisfactory results of the V-shaped excision were to be attributed rather to the change in the configuration of the stomach following this operation, which did not follow complete transverse resection.

DR. JAMES M. HITZROT recalled a case in which he performed a V-shaped resection on the lesser curvature, with the subsequent report that the patient was improved by the operation. X-ray examination showed contraction of the lesser curvature which had changed the angle of the duodenum so that there was retention. Bismuth remained in the stomach for 17 hours. At the second operation it was found that there was a water-trap stomach, with adhesions along the posterior line of sutures. The patient was relieved by gastro-enterostomy.

DR. JOHN A. HARTWELL mentioned cases which he had seen operated at the Mayo Clinic, by the method of cauterizing directly through the ulcer, and suturing the defect thus produced. In cases where the ulcer was removed by a V-shaped resection, he thought in most cases it was better to do a gastro-enterostomy at that time.

## RESECTION OF SIGMOID FOR GANGRENE RESULTING FROM ENDARTERITIS OBLITERANS

DR. WILLIAM A. DOWNES presented a man, aged forty, who was admitted to St. Luke's Hospital on December 19, 1914, with a history of sudden seizure of severe cramp-like pain in the lower abdomen on the day before admission to the hospital. Previously there had been no gastro-intestinal symptoms, no jaundice, no diarrhoea, bowels had been regular as a rule, and patient had noticed no recent loss of weight

or strength. For the past year there had been pain in the legs, especially the left one, for which he had been "baked." There was a history of gonorrhœa at twenty; syphilis was denied.

The pain in the lower abdomen was a little worse on the left side than on the right, varied in severity, but was present constantly since its onset. There had been no movement of the bowels, and even though he had been given several enemata no flatus was expelled, although he passed a small amount of bright red blood following the enema. The patient had vomited several times since the onset of the pain and had been continually nauseated. There had been no frequency in micturition, but urination was difficult and less had been passed than normally. There was no pain in the back and no hæmaturia.

The entire abdomen was tender, with the tenderness most marked in the left lower quadrant. No masses or rigidity could be felt. Otherwise, the examination was entirely negative except that the legs and feet were cold and slightly cyanotic, with no pulsation in the arteries at the ankles. The temperature was  $100\frac{2}{5}^{\circ}$ , pulse 58, and respiration 30. The white blood count 28,000, polymorphonuclears 84 per cent., lymphocytes 16 per cent. Four hours later, white blood count 23,000, polymorphonuclears 84 per cent., lymphocytes 18 per cent. The urine was acid, clear, with a specific gravity of 1010. There was a very faint trace of albumin, no sugar, and few leucocytes and epithelial cells.

On December 21 an X-ray examination, bismuth series, showed the stomach to be normal in size and position. The emptying time was fairly normal, it being completely emptied in six hours. There were large amounts of gas in the colon. At the end of 47 hours, some of the meal had reached the splenic flexure and some was in the transverse colon. At the end of 54 hours after simple enema, there was some slight advance in the meal, which suggested delay in the sigmoid flexure.

On December 28, a bismuth injection travelled to the cæcum, but left a very peculiar appearance over the region from the splenic flexure to the sigmoid, which showed much narrowed calibre suggestive of a constriction or extreme spastic condition. Cystoscopic examination revealed nothing abnormal in the bladder or ureters. Wassermann test was negative, as was also the cerebrospinal fluid. Rectal temperature had been  $98^{\circ}$  to  $99\frac{2}{5}^{\circ}$  for eleven days.

The patient was operated on December 31 by a left rectus incision six inches long. After freeing omental adhesions, the sigmoid was found adherent to the peritoneum. It was dissected free and accidentally opened. A section of the sigmoid five inches long was removed and the distal end inverted with purse-string of fine Pagenstecher.

## FETAL ADENOMA OF KIDNEY

A lateral anastomosis was done between the terminal ileum and the distal end of the sigmoid. A stab wound was then made in the left upper quadrant with a gauze drain to the proximal stump of the sigmoid and a rubber dam drain to the site of anastomosis.

*Pathological Findings.*—From the lower portion of the sigmoid up to the splenic flexure, the colon was thickened and indurated. Tissue was very friable. At the level of the anterior superior spine the colon was adherent to the parietal peritoneum and the walls congested and cedematous. The omentum was adherent at this spot. The wall of the colon was thickened and appeared subacutely inflamed, but there was no suggestion of tuberculosis or malignancy. Pathological examination showed gangrene of the descending colon, obliterative endarteritis and chronic inflammation.

## FETAL ADENOMA OF KIDNEY; NEPHRECTOMY

DR. CHARLES H. PECK presented a girl, aged three years and eleven months, who was admitted to Roosevelt Hospital on November 6, 1914, with a history of having complained about three months previously of occasional abdominal pain, relieved by catharsis. Little attention was paid to it by the mother, and nothing wrong was noticed further until early in November, when a swelling in the right side of the abdomen was first discovered. She was then brought to the hospital. The swelling was found to be a tumor of the right kidney as large as a grape-fruit. The child was considerably emaciated, but otherwise did not seem ill. The tumor was thought to be probably malignant, but operation was advised. The parents refused and took the child away.

The child was not seen again until January 14, 1915, when she was again admitted to the hospital. In the interval she had emaciated greatly, the tumor had increased in size enormously, and the superficial abdominal veins were dilated. The child was very anæmic and the outlook seemed almost hopeless. The parents now wished operation as they had finally become convinced that the child was failing rapidly.

The hæmoglobin was 39 per cent., red cell count 3,700,000; leucocytes 9400, polymorphonuclears 80 per cent. The size of the tumor, the anæmia and cachexia made the outlook seem nearly hopeless, but after careful consideration the attempt at removal was finally decided upon and undertaken on January 16.

Enucleation was effected with a good deal of difficulty. The capsule was quite adherent in many places and at the upper pole some necrotic portions of tumor had to be removed before delivery could be effected. An opening in the peritoneum was made intentionally in the course of

## NEW YORK SURGICAL SOCIETY

enucleation, and altogether the delivery was much more difficult than is often the case in these encapsulated kidney tumors. It was finally effected, however, and the pedicle was satisfactorily secured. The wound was closed, with a small dressed tube drain placed posteriorly.

The operation was fairly well borne and the shock moderate, considering the difficulty of the procedure and the great amount of trauma. The child's convalescence has been uninterrupted and she has gained considerably in weight and general condition.

DR. WILLIAM A. DOWNES had had nine of these cases at the Babies' Hospital. Four had died as immediate result of the operation. Of the remaining five, all died later, with the exception of one, operated two months ago. He doubted, however, if this patient would live very long. Various diagnoses had been made in each case.

DR. FREDERIC KAMMERER's experience had been that most of these tumors recur very soon after operation. In very large tumors unexpected difficulties might arise during operation. In one of the last cases the speaker had operated on, a girl of seven, the separation of the large mass from the surrounding tissues was rather easily accomplished until the pedicle was reached. There the tumor-mass had enveloped the large vessels and, in attempting to free the pedicle, the left renal artery was torn or cut from the aorta, causing a hemorrhage, to which the patient succumbed.

### END RESULTS OF HIGH FREQUENCY CAUTERIZATION OF VESICAL PAPILOMATA

DR. EDWIN BEER presented three cases, bringing their histories as published in detail in the *ANNALS OF SURGERY* for August, 1911, up to date.

The first patient, who was a woman eighty-one years of age when first seen, was admitted to Mt. Sinai Hospital, First Surgical Service, on February 24, 1910. According to the history, she had had hæmaturia irregularly for two years, passing clear urine between attacks, with increased frequency during attacks, and without pain. There had been loss of weight and strength. Upon physical examination the patient was found to be poorly nourished and very anæmic. Cystoscopy showed a large papillary growth stained with blood, surrounding the right ureteral meatus and extending well to the right towards the lateral wall. The villi were very exuberant, protruding approximately 2 cm. into the lumen of the bladder. The growth was slightly ovoid in shape and of the size of a silver dollar, the main part of the growth being to the right of the right ureteral meatus and apparently sessile. To



#### HIGH FREQUENCY CURRENT FOR VESICAL PAPILLOMATA

remove the growth and re-implant the ureter would have been too severe a strain for a patient of this age and in her poor condition. In eight seances, aggregating  $13\frac{1}{4}$  minutes total application of the Oudin current, the tumor was painlessly destroyed, and the patient had been completely restored to health.

This patient has been recystoscoped 12 times during the past 5 years and shows no sign of recurrence.

The second patient, a woman sixty-six years of age, was admitted to Mt. Sinai Hospital on April 6, 1910. The symptoms began ten years before, with hæmaturia lasting several weeks, increased frequency of urination, and burning on urination. In June, 1907, she had a second attack of hæmaturia lasting three months. At that time Dr. Beer cystoscoped the patient at the German Hospital and found a papillary tumor the size of a hazel-nut a little to the left of the left ureteral meatus. The patient refused operation. One year before her admission to the hospital the third attack of hæmaturia began, lasting two weeks. The fourth attack began nine weeks before admission. When admitted to the hospital the urine was very bloody, frequently containing large clots. Urination was every half hour during the day, and three or four times at night. There was marked tenesmus. The patient had lost much weight and was steadily growing weaker. Patient was almost exsanguinated. At the first treatment the bleeding ceased, so that the tumor was readily seen in subsequent examinations. It was made up of fine villi and coarse bulbous papillæ, it was sessile, and of about the size of a half-dollar. By means of the high-frequency current (Oudin), employed in four seances aggregating 14 minutes' application, the growth was totally destroyed.

This patient has been recystoscoped about 12 times during the past 5 years and no signs of recurrence are visible.

The third patient, a man fifty-four years of age, presented symptoms of tumor dating back 22 years. Examination showed one of the most extensive papillary growths he had ever seen. The tumor stretched from the neck of the bladder across the trigone, over the left ureter, and the left two-thirds of the trigone, thence up the left lateral wall and posterior walls to well above the equator, taking in between one-quarter and one-third of the whole bladder wall. This patient was difficult to treat, not only because of the great size of the growth but also on account of severe bleeding and of bladder irritability. In 9 seances aggregating 34 minutes' application of the current, the whole tumor was destroyed and gradually thrown off in large and small pieces. The patient was restored to excellent health.



## NEW YORK SURGICAL SOCIETY

This patient has been recystoscoped 8 times during the past 4 to 5 years and his bladder shows no sign of recurrence.

NOTE.—*These three cases are the original cases on which the high frequency cauterization method was employed and constitute the first three cases on which this new technic was tried.*

### TRANSPERITONEAL RESECTION OF BLADDER FOR CARCINOMA; ENUCLEATION OF PROSTATIC ADENOMA

DR. BEER presented a man, aged sixty years, who, three years ago, began to have painless hæmaturia. In April, 1912, cystoscopy revealed on the posterior wall of the bladder a rather fleshy, slightly papillary growth, the size of a silver half-dollar. This was immediately treated with the high-frequency current. Specimens obtained during treatment and in voided urine were at first unsatisfactory. Cystoscopy was difficult, as the patient had a large prostate. After the second treatment the specimen obtained showed malignancy. This, together with the cystoscopic picture and the failure of the cauterization to destroy the greater part of the tumor, compelled him to do a partial cystectomy, on July 12, 1912. The whole posterior wall into the trigone was excised transperitoneally, and the defect was then closed by two layers of sutures, an inner chromic gut, and an outer Pagenstecher (continuous). A tube was placed in Douglas's pouch and, the bladder being completely closed, a permanent catheter was introduced through the urethra. Microscopic examination showed an infiltrating carcinoma. The patient made a satisfactory recovery. As the catheter did not work well it was removed, and the patient voided spontaneously after the first day. About eight weeks after this operation the patient began to have severe pains on urination, and it was thought, by several surgeons whom he consulted, that he had a recurrence. His symptoms suggested stone, and X-ray examination showed in December, 1912, two shadows in the bladder region. The original incision was opened and two calculi were removed, after separating their attachment to the bladder wall, to which they were hanging on the Pagenstecher suture. At this operation all the suture material that was visible was excised. There was no evidence of recurrence of the growth. The prostate was distinctly enlarged. By February, 1913, another stone had formed, and on cystoscopy it was readily seen hanging by a thread into the bladder. Except for a cystitis and an intravesical projection of the prostate, the bladder was negative through the cystoscope. Again the bladder was opened, with the object of removing the stone and the prostatic adenoma, and following up the rest of the Pagenstecher linen and removing it. The linen

#### EXTRAPERITONEAL CAUTERY EXCISION OF CARCINOMA

had to be followed into the vesical wall and actually dissected out. The prostatic adenoma was easily enucleated and the stone removed. There was no recurrence of the original growth. The bladder was sutured down to a tube opening and in twelve days the patient was passing all his urine. Since the last operation the patient has been absolutely well and his urine perfectly clear. He has gained about forty pounds.

#### EXTRAPERITONEAL CAUTERY EXCISION OF CARCINOMA OF BLADDER

DR. BEER presented a man sixty-seven years of age, who in 1912 had the first attack of hæmaturia, and in April, 1914, a second attack, with pain and marked increase in frequency. There had been distinct loss of weight, and his general condition was poor. Cystoscopy and high-frequency treatment April 27, 1914. Cystoscopic examination revealed a rather solid papillary tumor on the right anterior wall, and another at the right ureteral opening. Both tumors were surrounded by thickened, cedematous mucosa. Pieces were excised through the operating cystoscope, from both growths, the pathological report being papillary carcinoma on the tumor of the right wall, and papilloma on the ureteral growth. Owing to the patient's wretched condition it was not deemed justifiable to attempt anything radical, and finally it was decided to open the bladder under local anæsthesia and to burn off the growths, thus temporarily controlling the pain and bleeding. April 29, 1914, after exposing the bladder extraperitoneally, it became evident that the right and anterior walls could be resected with some hope of getting out all the growth except the papilloma at the right ureter. Under chloroform, the bladder was completely freed on the right side from the perivesical tissues, which were apparently not involved, and then the bladder was opened and the surfaces of both growths Paquelinized thoroughly to avoid implants. Then, with the hooked cautery, the excision of the carcinoma was performed and the defect in the bladder closed with a double row of catgut sutures. The bladder was drained suprapubically. Recovery, much to the speaker's surprise, was uneventful, and the patient was discharged in four weeks.

Inasmuch as the whole procedure was done more with the hope of palliation than of cure, it was a great surprise to find, on examining the patient on November 5, 1914, that his bladder showed no signs of recurrence, and that he was free from all symptoms.

NOTE.—These cases illustrate the two methods of procedure in excising malignant bladder disease, the intraperitoneal and the extraperitoneal.

TRANSACTIONS  
OF THE  
PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, February 1, 1915*

The President, DR. JOHN H. GIBBON, in the Chair

INGUINAL LYMPHOMA

DR. D. L. DESPARD presented a man who had been operated on at the Jefferson Hospital for enlarged inguinal glands. The glands on the left side, smaller than those on the right, were not removed; the largest of the glands of the right side measured, three or four days after removal, 4 cm. in diameter. Microscopic examination showed simple hyperplasia of the lymphatic glands, without increase in the fibrous tissue and no evidence of eosinophiles except here and there; nothing to suggest sarcoma or Hodgkin's disease. The cells had the appearance of ordinary lymph cells. History was practically negative. There was no venereal history; Wassermann, negative. He had, however, a leucocyte count of 12,000. The red cells were increased in number to 6,200,000. Beyond this the blood picture presented nothing unusual. The differential count showed polymorphonuclear cells of 66 or 67 per cent., in other respects it was practically normal. The reporter said that he had never seen an ordinary hyperplasia in which the glands were as large as those on the right side in this case. The question is whether this is an incipient Hodgkin's disease or a pre-sarcomatous condition.

DR. JOHN H. JOPSON said that this case is similar to one in which he had operated for polyglandular enlargement of one side of the neck. Some of the glands were found to be broken down at the time of operation, and the appearance seemed to disprove the possibility of Hodgkin's disease or sarcoma. Pathologists in two laboratories reported the condition tuberculous. There was local recurrence and a second operation was done some months later. This time the glands were examined by Dr. Canby Robinson who reported typical Hodgkin's disease.

OPERATION FOR OLD FRACTURE OF THE PATELLA

DR. JOHN H. JOPSON presented a woman thirty-nine years of age, weighing over 200 pounds, who fell in 1912 and fractured her left patella. She was treated by another surgeon without operation, some



FIG. 1.—Separation of patellar fragments. Before operation.



FIG. 2.—Condition after operation; patellar fragments in apposition, tibial tubercle moved upward and fastened by pin.





## OPERATION FOR OLD FRACTURE OF PATELLA

form of an extension apparatus being applied to the muscles of the thigh to aid in bringing about apposition of the patellar fragments. She was in bed for two months; there was marked stiffness of the knee following the removal of the apparatus. Four months after the original accident, the fragments became separated during passive motions. She was again in bed for one month. Considerable stiffness persisted and she had some effusion of the joint, but finally she got around with a cane.

In December, 1913, she fell again, injuring this knee. When examined by the reporter, February, 1914, a wide separation of the patellar fragments was found, at least two inches when the limb was extended and correspondingly more when it was flexed. The femoral condyles were plainly felt between the fragments and there was apparently no union. There was a complete loss of power of extension in the knee and the patient could walk only with a cane and had no confidence at all in the strength of the limb. X-ray examination showed two fragments, each of good size, widely separated (Fig. 1). At operation, in March, 1914, the fragments were exposed by the usual curved incision, convex downward. The fragments were connected by a broad, very thin, relaxed sheet of fascia, which permitted complete flexion, but was of no service in extension. There were many adhesions around the fragments and the quadriceps muscle. The broken edges were covered with a thick layer of fibrous tissue. The first step toward approximation of the fragments was a division of the lateral expansions of the quadriceps and loosening of the under surfaces of the two fragments from their adhesions to the underlying bones. A plastic operation was done on the quadriceps tendon by making a V-shaped incision with the apex downward, which manœuvre diminished by about two-thirds the distance between the fragments. The vastus internus and externus were extensively mobilized. As it was still impossible to approximate the fragments, they being about three-quarters of an inch apart, the tubercle of the tibia was chiselled loose from the bone, remaining attached to the patellar tendon and the periosteum on each side, which permitted of its being elevated about  $\frac{3}{4}$  of an inch and the fragments of the patella could then be brought into contact, there being some slight tilting of the lower fragments. Both fragments were drilled and a heavy silver wire and two chromic catgut sutures were used to fasten them together. A wire nail was driven through the separated tubercle into the head of the tibia at its new level. The lateral expansions were sutured, the quadriceps tendon repaired, the thin, tendinous flap formerly uniting the fragments used

to overlap them. The fat, fascia and skin wounds were sutured, and drainage provided at either angle, the wound being dressed on a posterior splint. There was some superficial necrosis of the fat due to the prolonged manipulation at operation, otherwise convalescence was normal. A splint was worn for three months, passive motions being practised after the wound was healed. There was marked stiffness at first, but this yielded to passive motion and massage. At the present time, the result is as follows: Flexion is almost complete, extension is strong to a point 15 or 20 degrees from the straight line, passive extension is perfect. The patient can walk long distances. She can stand with all her weight on the leg. The patella is movable and the only disability is in going up and down stairs, when she still fears to bring the injured knee ahead of the other. The X-ray (Fig. 2) shows excellent apposition and union of the fragments, union of the tubercle of the tibia with some tilting, and the nail, which still remains, has worked into an oblique position in the head of the tibia, but causes no annoyance. The incompleteness of extension is probably due to the high insertion of the patellar tendon with some loss of lever action in consequence.

The case illustrates what can be done in old fracture of the patella, with wide separation, by a combination of a plastic operation on the quadriceps tendon with von Bergmann's method of elevation of the tibial tubercle. Either of these measures alone would have been insufficient to secure approximation in this case, and, while the former has been criticised for resulting in a weakening of the muscle and the latter for not accomplishing very much in the way of approximation, the combination of the two in this case has resulted in a strong, useful limb. One criticism which might be aimed at the elevation of the tibial tubercle is one used by Turner, that it may prejudice the mobility of the joint. There is some slight loss of the power of complete extension here, although this may in time be overcome.

DR. GEORGE G. ROSS spoke of a case in which the interval between the time of the accident and of operation was five years. There was a separation of from  $2\frac{1}{4}$  to  $2\frac{1}{2}$  inches between the fragments. He was able to bring the two fragments together, apparently in perfect apposition, secured by heavy silver wire. Fourteen days later, the patient being still in bed, the wire was snapped by a contraction of the quadriceps muscle, producing a  $\frac{3}{8}$  inch separation. She went about in this condition for a year and then the broken end of the silver wire produced a sinus, for which operation was done. While under the anæsthetic another attempt was made to bring the fragments together. They did not

## NASAL OSTEOCHONDROMA

get bony union but a good strong fibrous union with good functional result, giving the woman a very useful limb. The problem in this case to be overcome was atrophy and shortening of the quadriceps muscle. No operation upon the tendon was done. It was forced down, but was not successful in entirely overcoming the shortening of the muscle.

### TRANSPLANTATION OF ENTIRE BONES WITH THEIR JOINT SURFACES

DR. A. BRUCE GILL read a paper with the above title, for which see page 658.

DR. GWILYM G. DAVIS thought that the question, whether or not the bone transplant is absorbed, is perhaps not of great importance. Some of Albee's work, and the work of others, have shown that if the bone is replaced it is replaced almost absolutely in the size and shape of the original bone as inserted. Therefore, whether it is replaced or not replaced, the effect is the same. Suppose if a person has a fracture in the shaft of a long bone, nobody would say that after healing either fragment had been entirely replaced by a new bone. Suppose a fracture occurs close to the articular end, as in Colles' fracture of the radius, does not the distal fragment live? In an osteotomy for hallux valgus back of the articular surface in which the bone is brought straight, does the head of the bone become absorbed and replaced? He hardly thought so. In one such case he took the head of the bone completely out, put it back, and closed up the wound. Healing occurred and the condition was as satisfactory as in the opposite side in which the head of the bone did not come out. Was the transplanted bone absorbed or not absorbed? Experiences like this are not rare even though one cannot positively explain the process from an academical point of view. The implant seems at least to retain its vitality and live very largely in the shape in which it has been implanted. Some of Albee's specimens are very marked illustrations of that. It seemed to him to be begging the question when one sees some of his transplantations of bone of the spine in which the implant is fused absolutely *in situ* and remains almost exactly as when implanted, to question the process. Of course, when a bone dies the death is more or less *en masse* and such grafts come away as sequestra.

## NASAL OSTEOCHONDROMA

DR. NATHAN P. STAUFFER presented a man, aged thirty years, who had been operated upon two years ago in the Jefferson Hospital for an obstructive growth in his nose. When first seen he had great pain in nose and was unable to breathe through either nostril.

## PHILADELPHIA ACADEMY OF SURGERY

A large hard mass protruded from the right nostril. It pressed the septum over, occluding right and left nostrils. Postnasally it could be seen extending to the uvula and appeared to be of connective tissue, well supplied with blood-vessels which easily bled. X-ray report stated that the growth was in or extended into the right maxillary sinus. A tentative diagnosis of sarcoma of the nose was made and immediate operation advised. Operation refused and postponed on account of his wanting to keep a newly acquired job.

September 15, 1914, four months later, he returned with more pain in his nose and severe darting headaches and diminishing vision. Externally nasal bones were pushed out and the face much swollen. He was sent to the Presbyterian Hospital for operation, where on the following day he was anesthetized by the Meltzer intratracheal method. The tracheal tube was lightly packed into the pharynx with two long strips of gauze to prevent inhalation of any blood *via* postnares and mouth, hæmostats were attached to these to keep them in place; the lips being elevated by a retractor, a labiogingival incision made, and the mucosa elevated to the inferior nares. He then cut through the inferior nasal mucosa from below and retracted the tissues but could not get around the growth. The incision was then enlarged by chiselling through the lower portion of the pyriform opening. The tumor was found apparently attached to the anterior end of the inferior turbinal bone. With the scissors this was severed and a large piece shelled out with a broad curette. The growth extended posteriorly, and piece by piece it was dissected from the mucosa of the right side. A large perforation was found in the septum and the growth filled the entire left naris, partially eroding the left maxillary antral wall. Finally with a finger in the postnares the rest of the mass was easily dislodged. Dr. Speese with the electric needle cauterized the inferior nares where it had been attached and the nose was irrigated with bichloride and packed with iodoform gauze. The labiogingival wound was stitched with catgut and the intratracheal apparatus and postnasal gauze were removed, as the anterior nasal packing was considered capable of controlling hemorrhage. His only bleeding came from the labiogingival wound, which was readily controlled by packing with a strip of one inch gauze. The subsequent convalescence presented no serious complication and he returned home at the end of two weeks. The pathologist reported the growth to be an osteochondroma.

Two months and a half later, December 12, 1914, renewed examination revealed a growth springing from the middle third of the inferior turbinal, possibly with a base in the maxillary antrum.



## CYSTADENOMA OF THE PANCREAS

The operation succeeded in giving him good breathing space day and night, relieved his headaches, increased his vision and relieved his embarrassment while eating.

The question of recurrence is to be determined but the growth can be removed more readily now that it can be seen when first starting and as it is destructive apparently only by pressure this can be prevented by operating. The only other report of a case of nasal osteochondroma that he could find is by Dr. Robert Myles in the *Laryngoscope*, page 305, and is interesting in that he had to ligate the external carotid artery to control the hemorrhage.

## CYSTADENOMA OF THE PANCREAS WITH EXTENSION TO THE ABDOMINAL WALL TEN YEARS AFTER DRAINAGE OF A PANCREATIC CYST

DR. JOHN J. SPEESE reported the history of a woman aged forty-nine years, who was first admitted to the Presbyterian Hospital in 1904, where she was operated upon by Dr. Duer for a large cyst of the pancreas.

The cyst wall was so adherent to the omentum and intestines, and the condition of the patient such that prolongation of the operation for the purposes of exploration was not warranted. The neck of the cyst was accordingly sutured to the abdominal wound and a considerable portion excised. The patient made an uninterrupted recovery, the sinus healing completely at the end of two months. Examination of the cyst contents showed pancreatic ferments; the histological examination of the cyst wall revealed fibrous tissue and no lining.

The patient was readmitted to Dr. Jopson's service on October 13, 1914, with a tumor of the abdominal wall which began three years ago as a small ulcer in the region of the umbilicus. Recently the growth has been rapid, measuring at present 5 cm. in diameter, and presents an ulcerated red surface, projecting slightly above the surrounding skin (Fig. 3). The edges are hard and indurated, the tumor is friable and bleeds easily, there is an offensive watery discharge which is non-irritative. The umbilicus is apparently involved in the tumor mass.

The growth was regarded as a primary carcinoma probably originating in the umbilicus, and was removed by a circular incision. The base of the tumor, however, was found to be attached to the abdominal organs by a definite pedicle, and on opening the abdomen, multiple



small cysts were found, the small intestine and the transverse colon were so firmly adherent that it was impossible to explore the region of the pancreas or to do any form of radical operation other than removal of the superficial tumor from its pedicle. The wound was closed as in the Mayo operation for umbilical hernia, and a small drain inserted down to the stump of the pedicle. The patient made a slow convalescence, the sinuses gradually closing, but draining a small quantity of fluid when last seen, February 1, 1915.

The examination of the patient's stools showed no abnormality in digestion. The urine contained small amounts of albumen but no sugar. The quantity of fluid in the cysts removed with the tumor was too small to examine for ferments.

*Pathological Examination.*—The specimen consists of a tumor which is entirely surrounded by an intact area of skin. The mass projects 1 cm. above the level of the skin, is round in shape and measures 5 cm. in diameter and 3 cm. in thickness. The tumor is bright red in color, the surface presenting small areas of ulceration, and at its lower pole is partially covered with skin to which it is firmly attached, while at the upper margin there is a distinct furrow between the tumor and the skin. The base of the tumor contains a smooth glistening membrane (peritoneum) to which several masses resembling omentum are attached. A cross section shows that the mass is composed of tissue which is white in color, dense in consistency and contains numerous cysts varying in size from a pinhead to cavities 1 cm. in diameter. The cysts contain a colorless mucilaginous fluid, the walls are smooth in appearance.

On microscopic examination the sections show a process consisting of a dense connective tissue stroma in which are embedded glandular elements presenting various stages of activity. For the most part the acini are fairly large and present a very moderate degree of dilatation. In these acini and in the smaller cysts the lining is composed of high cylindrical epithelium containing many goblet cells, and the cysts are filled with a blue mucoid material containing desquamated cells. In many of the cysts the epithelium is greatly compressed and is flattened in appearance; in others it is thrown into folds by reason of fibrous ingrowth so that many minute papillary processes are present. Toward the superficial portion of the tumor the cystic nature is less marked and the acini more numerous. The slightly dilated glands are found immediately beneath the skin surface, the squamous lining of the latter has become broken and in some places is in direct apposition with the cells of the acini. In this area the stroma contains a round-cell infiltration and traces of blood pigment. Many blood-vessels are found in the stroma, but no evidence of normal pancreatic tissue can be found anywhere.

The diagnosis of a *proliferating cystadenoma of the pancreas* with extension to the abdominal wall at the point of drainage ten years previously, is based upon several factors. There can be little doubt concerning the original diagnosis of pancreatic cyst as ferments were found in the fluid. The findings at the second operation coincide with the picture frequently met with in such cases, and the histologic examination points to the same conclusions.



FIG. 3.—Cystadenoma of pancreas extending to abdominal wall.

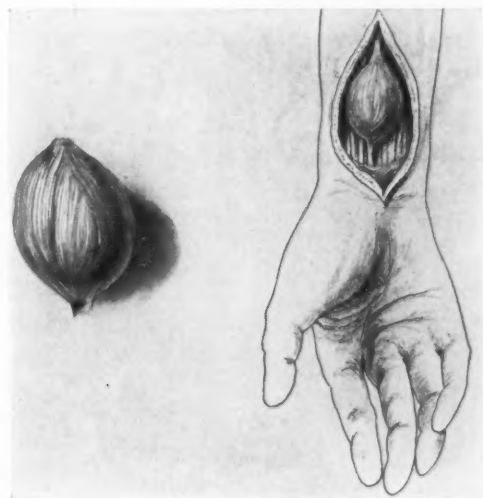


FIG. 4.—Cyst of median nerve.



#### CYST OF THE MEDIAN NERVE

Of the many interesting facts brought out by a study of the case, emphasis can be made upon the very benign and comparatively mild course of the new growth, a fact noted by all writers on this subject. It would seem that drainage of the large cyst retarded further growth for many years, and doubtless many more would have elapsed without trouble if extension of the process had not been favored by the attachment of the large cyst to the abdominal wall. It is also noteworthy that sugar was not present in the urine during either stay in the hospital and that the growth had little or no effect upon the general health or nutrition of the patient.

#### CYST OF THE MEDIAN NERVE

DR. SPEESE also related the history of a woman, aged sixty years, who struck her forearm two years ago in falling. She experienced very little pain from the injury, but noted shortly afterward that there was a distinct swelling above the wrist, and that this gradually enlarged but caused no discomfort. Three weeks ago she felt a sudden sharp pain in the forefinger, the pain radiating to the elbow. The severity of the pain has increased, becoming constant, at times interfering with sleep, and is unrelieved by any local or general measure. The patient asserts that the pain never arises in the tumor itself, always in the forefinger, radiates upward, and rarely is localized to the swelling in the wrist. She is able to use the fingers although motion causes some pain; there is no loss of sensation or atrophy of the hand. On examining the swelling, pain was caused by pressure over the tumor, which was oval in shape, three inches above the wrist and in the line of the median nerve. There is no pulsation, the enlargement presented the characteristics of a cystic formation.

The tumor was exposed under local anæsthesia, the slightest manipulation causing great pain until the median nerve was blocked by an injection of cocaine solution. The nerve above and below the cyst was exposed, at the upper pole the nerve fibres divided and many could be traced running over the external surface of the cyst from which they were dissected. The patient, a sufferer from a severe form of cardiac disease, insisted that the operation should afford permanent relief from pain and that she felt unable to undergo another operation. It was therefore necessary to divide the remaining fibres, and thus remove the cyst. The loss of nerve tissue was too great to approximate the cut ends, although there were several fibres uniting the nerve.

## PHILADELPHIA ACADEMY OF SURGERY

The patient was entirely relieved of the pain, the nerve fibres which were preserved evidently supplied the thumb, for sensation partially persists here, but sensation and motion are lost in the second and third fingers.

*Pathological Examination.*—Specimen consists of a round cystic tumor measuring 3.5 by 3 cm. The wall of the cyst is 4 mm. in thickness, is white and fibrous in consistency. At one pole of the cyst a section of nerve is seen from which small fibrils radiate and spread out over the external surface of the cyst. The cyst is filled with a blood-tinged fluid, its wall is smooth and contains traces of brownish pigment.

On microscopic examination the cyst wall is composed of two layers, the outer consisting of bundles of hyaline fibrous connective tissue containing comparatively few cells and a few blood-vessels. The inner portion or that which corresponds to the lining of the cyst is composed of a very cellular tissue, many new blood-vessels, a small amount of fibrous tissue and traces of blood pigment. The appearance resembles granulation tissue. Sections stained by Weigert's method do not reveal any nerve tissue in the inner portion of the cyst wall, but show remnants of nerve fibres attached to the external coat. The nerves are surrounded by a considerable amount of fibrous tissue and are the seat of degenerative changes.

The diagnosis of a blood cyst in the substance of the median nerve can be made from the above findings. This condition seems exceedingly uncommon as no mention of it is made in numerous text-books. It was unfortunate that the relief of pain was the chief indication for operation, as preservation of sensation and motion might have been maintained by less radical measures.



## BOOK REVIEWS

ANIMAL EXPERIMENTATION AND MEDICAL PROGRESS, by WILLIAM WILLIAMS KEEN, M.D., LL.D. Boston and New York: Houghton Mifflin Company, octavo, pages 312.

In this book are brought together the papers and addresses pertinent to the topic of the volume that have been made by the eminent author during the last thirty years, beginning with the address, *Our Debts to Vivisection*, which was made before the Woman's Medical College of Pennsylvania in March, 1885.

To the book is added an Introduction by Ex-President Eliot of Harvard, which is practically a review of the book. As Dr. Eliot says:

"Dr. Keen describes in this book, in a very interesting and convincing manner, the new surgery of the last forty years, and its extraordinarily beneficent results. He shows that the progress of surgery has taken effect in all parts of the human body, including the brain, spine, chest, stomach, intestines, liver, gall-bladder, appendix, pancreas, spleen and kidneys, and the arteries, veins and nerves; that many operations which were impossible or had a high mortality, before aseptic surgery was invented, have become not only possible, but safe, and that innumerable lives have been saved, and are continually being saved by operations new within forty years. He also demonstrates that the new surgery has reduced very much the period required for recovery, as well as the death rate, after a large variety of operations, such as those for compound fractures, ovariectomy, hernia, goitre, and the removal of cancers and tumors, and that the proportion of complete and rapid cure after operation has been greatly increased. He points out that lockjaw has been almost abolished; that the direct transfusion of blood has been achieved; that the mortality from diphtheria and cerebro-spinal meningitis has been greatly reduced, that yellow fever has been abolished as a destructive epidemic and that child-birth fever, formerly very destructive, has become rare.

"The new surgery has been made possible by the combination of anæsthesia and asepticism, but asepticism owes to animal experimentation, guided and furthered by the new science and art of bacteriology, its origin and its successful application.

## BOOK REVIEWS

"The immense benefits which modern surgery and serum-therapy have conferred on mankind are therefore due to animal experimentation."

The opinion and judgment of such a man as Dr. Eliot must carry with it a great deal of weight. It brings much encouragement and hope to the scientific surgeon of the present day in the midst of the great cloud of opposition and obloquy, of sentimental misrepresentation and exaggeration in which the subject of animal vivisection is annually involved through the efforts which are made by the so-called anti-vivisectionists with every recurring session of our State Legislatures to secure the passage of legislation tending to hamper legitimate, scientific investigation.

Dr. Keen, however, needs no authority to vouch for him. His own eminence as an educator, as a public spirited citizen and a practical surgeon is sufficient to give the greatest possible weight to his statements and opinions.

The volume, which is the result of the gathering together of the various addresses which he has made on the subject of animal experimentation during so many years, is one of the highest value as a handbook from which every one may draw authoritative statements on every conceivable phase of the question. The unreasonableness, inaccuracy and indifference to truth manifested by the opposition to animal experimentation are repeatedly exposed in these pages, and no one with an open mind can read its pages without a conviction as to the peculiar obliquity with which certain minds are sometimes seized when they approach questions with regard to which they are prejudiced, and of which they have little practical knowledge.

We commend this volume to every one who, either as a scientist or a philanthropist, is interested in the welfare of mankind. Especially should it be in the hands of every legislator to whom these questions come for ultimate action in the way of legislation, and also in every newspaper office from whence must come those published statements that mould so powerfully public opinion. With regard to the merit of the question, one can have but little doubt as to the ultimate result. "Truth is mighty and will prevail" is as true in the domain of animal experimentation as in any other department of life. Should there be at any time the temporary success of ill-advised and hysterical sentiment, the philosopher has but to bend his head to the storm and await the time, which will not be long delayed, when reason shall resume its sway.

LEWIS STEPHEN PILCHER.

## BOOK REVIEWS

COLLECTED PAPERS BY THE STAFF OF ST. MARY'S HOSPITAL, MAYO CLINIC, ROCHESTER, MINNESOTA. W. B. Saunders Co., Philadelphia and London. Volume for 1913.

The annual publication of a volume of papers from the Mayo Clinic is very properly looked forward to with much interest by the medical profession of this country. The book is made up of the publications which have originated at the clinic in Rochester during the year. It represents work accomplished. In the present issue 300 pages, or more than one-third of the whole volume, are devoted to the alimentary canal; 136 pages are devoted to the urino-genital organs; and over 100 pages to the ductless glands. A detailed analysis or report of such a varied collection of papers is impossible. The purpose of this notice of the publication of this volume from the Rochester Clinic is to call attention to the splendid work that is being recorded from this great institution. The recently proposed intimate relationship between the Medical Department of the University of Minnesota and the Rochester Clinic must add emphasis to the important place which this clinic holds in medical education in this country. This volume should be consulted by those wishing to know of the activity of this clinic and by those desirous of keeping in touch with the latest advance in surgical therapeutics.

CHARLES L. SCUDDER.

ABDOMINAL OPERATIONS. By SIR BERKELEY MOYNIHAN, M.S. (London), F.R.C.S., Leeds, England. Third Edition. Two octavo volumes. 980 pages, 371 illustrations (5 in color). Philadelphia and London. W. B. Saunders Company, 1914.

Moynihan's book is to be considered as a monograph upon surgical procedures which he himself puts into practice. He does not attempt to review the work of others, or to incorporate in his observations the various steps in technic which they advocate. While this course seems to present some disadvantages, still it enables one to form a good judgment as to the surgical work of the author.

It is to be remarked that there are no gynecological operations described, only those have been included which are common to the two sexes. Also, the surgery of the organs which are partly intraperitoneal and partly extraperitoneal, such as the kidney and bladder, he has not considered, nor are the operations for the various types of hernia included. Most of the work is taken up in the depiction and description of those intra-abdominal operations which are most commonly used and which will be of most benefit to those reading the book,

## BOOK REVIEWS

without confusing them with a mass of detail, relative to the care of conditions in which particular or special methods of operative conduct must be instituted.

Mr. Moynihan has reached the conclusion that any detailed reference to mechanical appliances for intestinal anastomoses may well be omitted, as he considers "all use of the button and bobbin to have served its purpose, and that their interest now is only historical." There are some, we feel sure, who will take exception to such a statement as this, and believe that there are occasions which arise in which the institution of either is most applicable and efficacious.

The present edition is divided into two volumes—the first of which is subdivided into three sections, taking up General Considerations, such as, the necessary preparation for abdominal operations and the technic of the operation itself; the after-treatment of the patient; the various incisions; the treatment of wounds of the abdomen; acute and tubercular peritonitis; subphrenic abscess and the surgical treatment of visceral prolapse.

Many of the observations in these chapters, especially in that chapter devoted to the preparation and after-treatment of the patient, are of great interest. The method of the anoci-association and nerve blocking is thoroughly developed, and we note the incorporation of some dietetic rules which have lately been found to give the patients after operation much greater comfort.

The author's method of early removal of intra-abdominal drains and his reason for his procedure, are very important and are to be carefully noted. His only reference to the treatment of post-operative intestinal paresis is the administration of infundibula extract. It might have been well to have mentioned some of the other methods which are employed, particularly where one is not in a position to obtain this agent.

Section Two deals with the operations upon the stomach, and is complete and exhaustive. The author's extraordinary experience in this class of cases leads him to lay down rather dogmatic rules which he has found essential to his success.

The Third Section of the first volume takes up the various operations upon the intestines, which consideration is continued in the first part of the second volume, which is also an exhaustive monograph upon the subject and many original observations are to be noted.

The author has had prepared with great care a large number of illustrations showing the various methods of suturing of the gut under varying conditions, which are most instructive and easily comprehended.



## BOOK REVIEWS

The last two sections of the second volume take up the surgery of the liver and gall-bladder and the operations upon the pancreas and the spleen.

The entire work constitutes a consideration of operations upon the essential intra-abdominal organs, written in the author's concise manner, and represents an exhaustive exposition of the more important methods of operation which are used at present by the majority of our more prominent surgeons, and will certainly prove a most valuable guide and reference book for those interested in this subject.

JAMES TAFT PILCHER.

SELECTED PAPERS, SURGICAL AND SCIENTIFIC, FROM THE WRITINGS OF  
ROSWELL PARK, with a Memoir by Charles G. Stockton, M.D.,  
Buffalo, 1914.

This book appeals in a special manner to the ANNALS OF SURGERY, for among the earliest friends gained by the new publication, thirty odd years ago, was a young surgeon of Chicago, who not only contributed the record of his own work to its pages, but also took an active personal interest in bringing it to the attention of his friends in the West. Hardly a year passed during those earlier years without some paper from Dr. Park in the ANNALS OF SURGERY. From that time also dated a personal friendship which lasted throughout the whole life of Dr. Park. We welcome, therefore, with great interest this volume in which are gathered together many of his most important papers, prefaced by a memoir written by his colleague of many years in medical teaching, Dr. Charles G. Stockton.

Dr. Park's life was one of great activity. He had a faculty of doing his work easily. He had the qualities of a man of the world as well as those of a scientist. He was not only a brilliant clinician, but was an adept in the methods of minute research. He combined in himself in an eminent degree the qualifications which would mean success in any department of enterprise. The record of his life is full of stimulus and of encouragement and inspiration to all who are called upon to tread the path of surgical endeavor.

This volume in which the more important of his *opera minora* are gathered together presents a most interesting record and mirror of his work. Opposite its title page has been placed an excellent portrait which shows the lineaments of the man. The book is an ideal record of an ideal surgeon.

LEWIS STEPHEN PILCHER.



## CORRESPONDENCE

### A LEAD PROTECTOR FOR USE IN BONE WORK

EVERYONE who has had experience in bone surgery has found some difficulty in avoiding accidents on account of the drills or bone saws, especially the latter, getting caught in the towels, sheets, or gauze drapes

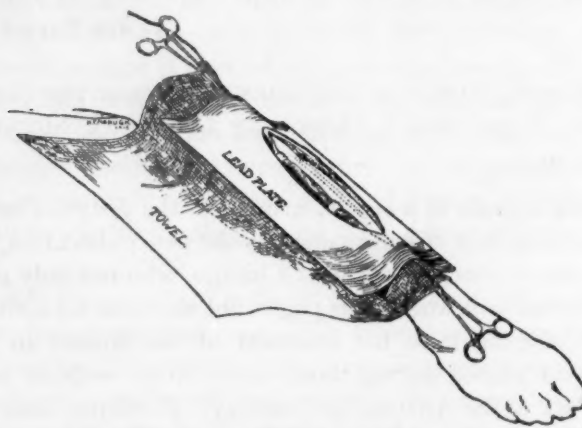


FIG. 1.—Use of lead protector in bone work.

which are used about the wound. To avoid these accidents I have used the plan illustrated (Fig. 1). A thin sheet of sterilized lead plate with a fenestrum of appropriate dimensions is laid over the operative field.  
Minneapolis, Minn.

R. E. FARR, M.D.

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## INDEX TO VOLUME LXI

### A

- Abdomen, Perforating Gunshot Wounds of the, 694.  
 Abdominal Operations, by Sir Buckley Moynihan, Review of, 765; Surgery, Review of, 512.  
 Adenoma of Breast, Calcified Fibro, 127.  
 Adhesions in Peritoneal Cavity, Post-operative Prevention of, 297, 365.  
 ALEXANDER, EMORY G.: Rupture of the Biceps Flexor Cubiti, 608.  
 Alum Cream, 124.  
 Amputation, Aperiosteal, Through Femur, 246; of Leg, Usefulness of Ventral Decubitus in Some, 616.  
 Anaesthesia, Inhalation, Influence of, on Acidity of Blood, 6; in Operations upon the Lung, 103.  
 Anastomosis, Lateral, of Blood-vessels, 597; Uretero-enteric, 273.  
 Aneurism, Arteriovenous, of Femoral Vessels, 367; Operation for the Cure of, 597.  
 Aneurisms, Subclavian, Ligature of Innominate Artery for, 641.  
 Angioneurotic Edema, Intestinal, Surgical Significance of, 324.  
 Animal Experimentation and Medical Progress, Review of Keen on, 763.  
 Anoci-Association, by Crile and Lower, Review of, 123.  
 Appendicitis, Complicated by Pylephlebitis, 589; Its Relation to Cholecystitis, 511.  
 Appendicular Obliteration, 438, 511.  
 Appendix, with Cæcum, in Sac of Strangulated Inguinal Hernia, 381; Perforated by Fish Bone in Sac of Strangulated Hernia, 356; in Sac of Strangulated Femoral Hernia, 355; Vermiform, Cystic Dilation of the, 582.

- Arterial Ligation for Exophthalmic Goitre, 500; Thrombosis and Embolism, Operative Treatment of, 519.  
 Artery, Innominate, Ligature of the, for Subclavian Aneurisms, 641.  
 ASHHURST, A. P. C.: Carcinoma of the Floor of Mouth, 637; Surgical Anatomy of the Upper and Lower Poles of the Thyroid Gland, 365.  
 Auditory Nerve, Fibrosarcoma of the, Extirpation of, 100.

### B

- BABLER, EDMUND A.: Pylephlebitis Complicating Appendicitis, 589.  
 BAINBRIDGE on the Cancer Problem, Review of, 378.  
 BALFOUR, DONALD C.: Tonsillectomy in Children, 257.  
 BARBER, W. H.: Uretero-enteric Anastomosis, 273.  
 BARRIE, GEORGE: Cancellous Bone Lesions, 129.  
 BECK-JIANU: Oesophagoplasty, 480.  
 BEEKMAN, FENWICK: Occlusion of Pylorus, 423.  
 BEER, EDWIN: Congenital Deformity of Large Bowel, 116; End Result of High Frequency Cauterization of Vesical Papilloma, 750; Fecal Fistula: New Method of Closure, 110; Nephrolithiasis with Perinephric Abscess, 111; Papillomatosis of the Bladder, 109; Transperitoneal Resection of Bladder for Carcinoma, 752; Treatment of Benign Papillomata of Urinary Bladder with High Frequency Current, 735; X-ray Pictures of Diverticulum of the Oesophagus, 363.  
 BENNER, H. O.: Red Stippling Sign of Gastric and Duodenal Ulcer, 380.

# INDEX

- BERNHEIM, BERTRAM M.: Blood-vessel Clamps, 96.
- Biceps Flexor Cubiti, Rupture of the, 608, 638.
- Bladder, Atony of, and Prostatic Obstruction, 276; Papillomatosis of, Carcinoma in Suprapubic Scar, 109; Urinary, Transperitoneal Resection of, for Carcinoma, 752; Urinary, Treatment of Benign Papillomata of the, with High Frequency Current, 735, 750.
- Blastomycosis, 513.
- Blood, Acidity of, Influence of Inhalation Anæsthesia on, 6; Protective Ferments of, for Transplantation of Organs, Abderhalden Method, 149.
- Blood-vessel Clamps, 96.
- Blood-vessels, Lateral Anastomosis of, 597.
- BOGART, ARTHUR H.: Surgical Significance of Intestinal Angioneurotic Edema, 324.
- Bone and Cartilage Tumors, Multiple, Congenital, 142; Grafts, Autogenous, versus Lane's Plates, 717; Lesions, Cancellous, 129; Transplantation, 672; Work, Lead Protector for Use in, 768.
- Bones, Transplantation of Entire, with Their Joint Surfaces, 658, 757.
- BOOKMAN, MILTON R.: Occult Strangulated Inguinal Hernia, Spontaneous Reduction "En Masse," 730.
- Boston City Hospital, Statistics of Gall-stones Treated at, 535.
- Bowel, Large, Diverticulitis of the, 343.
- BOWEN, DAVID R.: Bullet Localizer, 376.
- Brain, Endothelioma of the, Condition Three Years After Operation, 106; Surgery, 17, 101, 107.
- Breast, Adenofibroma of, Beginning Carcinoma, 351; Calcified Fibroadenoma of, 127; Myxoma of the, 126; Tumors of, Difficulties in Clinical Diagnosis of, 353.
- BRENIZER, ADDISON G.: Keloid Formation in the Negro, 83.
- BREWER, GEORGE E.: Occlusion of the Pylorus, 489; Röntgenologic Diagnosis of Surgical Lesions of the Stomach and Duodenum, 55; Treatment of Tuberculous Ureter, 473.
- Bronchiectasis, Extirpation of Right Lower Lobe of Lung for, 103; from Foreign Body in Lung, 254; Resection of Lung for, 114.
- Bronchoscopy in Cases of Bronchiectasis, 104.
- Bullet Localizer, 376.
- BURNHAM, A. CAMPBELL: Fracture of the Pelvis, 703.
- ## C
- Calcaneum, Fracture of the, with Fracture of Processus Posticus Tali, 372.
- Calculi, Intestinal, Formed Around Suture Thread, 332.
- Cancer of the Rectum, Major Procedure First in the Two-Stage Operation for Relief of, 446.
- Cancer Problem, The, 1; by William Seaman Bainbridge, Review of, 378.
- Carcinoma of Oesophagus, Operative Treatment of, 385.
- CARMAN, R. D.: Diverticulitis of the Large Bowel, 343; Multiple Congenital Osteochondromata, 142.
- CARNETT, J. D.: Fracture of Condyle of Lower Jaw, 505; Typhoid Spine, 456.
- CARROLL, ALBERT H.: Activity of the Pylorus Following Gastro-enterostomy, 567.
- CASTLE, OTTO L.: Cystic Dilation of the Vermiform Appendix, 582.
- Cerebellar Syphilis, Simulating Abscess, 97.
- Cerebral Surgery, 17, 107.
- CHANEY, R. H.: Prevention of Post-operative Adhesions in the Peritoneal Cavity, 297, 365.
- Children, Surgical Diseases of, Review of Kelly on, 118.
- Cholecystectomy, Technic of, 306.

# INDEX

- CHOYCE AND BEATTIE: A System of Surgery, Review of, 122.
- CHURCHMAN, JOHN W.: Double Internal Jugular Vein, 235.
- COFFEY, ROBERT C.: The Major Procedure First in the Two-Stage Operation for Relief of Cancer of the Rectum, 446.
- COLE, LEWIS GREGORY: Röntgenologic Diagnosis of Surgical Lesions of the Stomach and Duodenum, 55.
- COLEY, WILLIAM B.: Cancer of Testis, 634; Enchondroma of the Tibia, 635; Lymphosarcoma Treated by Mixed Toxins, 495.
- Colocolostomy, 176.
- Colon, Developmental Reconstruction of the, 166; Non-rotation of the, 111; Stasis, Clinical Aspects of, 334.
- CONNORS, JOHN F.: Strangulated Inguinal Hernia Containing Cæcum and Appendix, 381.
- COOK on Diseases of the Rectum and Anus, Review of, 377.
- Craniotomy, Technic of, 107.
- CRILE, GEORGE W.: Influence of Inhalation Anæsthesia on Acidity of Blood, 6.
- CRILE AND LOWER: Anoci-association, Review of Treatise on, 123.
- Cyst of Median Nerve, 761.
- Cystadenomata, Multilocular, of Retroperitoneal Origin, 312.
- D**
- DAVIS, BENJAMIN F.: Hemorrhagic Erosions of the Oesophagus, 261.
- DAVIS, GWILYM G.: Arteriovenous Aneurism, 370; Introduction of Catheter Through Ruptured Urethra, 240; Transplantation of Entire Bone, 757.
- DAVIS, JOHN STAIGE: Osteogenic Power of Periosteum, 672.
- DAWBARN, ROBERT H. M.: Alum Cream, 124; Lung Abscess from Inhalation of Tooth, 255; Technic of Amputation of Thigh, 247; Technic of Operation for Preservation of Iliohypogastric Nerve in Operation for Inguinal Hernia, 250.
- DEAVER, JOHN B.: Mortality Statistics of Two Hundred and Seventy-Six Cases of Acute Intestinal Obstruction, 198; Relation of Appendicitis to Cholecystitis, 511.
- DELATOUR, H. BEECKMAN: Persistent Embryonal Type of Large Intestine, 73.
- DERBY, RICHARD: Gunshot Injuries of Spinal Cord, 686.
- DESPARD, D. L.: Inguinal Lymphoma, 754.
- Diverticulitis of Large Bowel, 343.
- Diverticulum of the Oesophagus, Complicated by Abscess of the Lungs, 360.
- DOUGLAS, JOHN: Dislocation of Semilunar Bone, 472; Surgical Treatment of Gastrocoloptosis, 545.
- DOWD, CHARLES N.: Mesenteric Cyst, 481; Preservation of the Iliohypogastric Nerve in Operation for Cure of Inguinal Hernia, 204; Relation of Nerve Distribution to Inguinal Hernia, 483; Septic Meningitis, 482.
- DOWNES, WILLIAM A.: Cases of Recurrent Hernia After Operation, 252; Gall-stone Ileus, 243; Gastrop-tosis with Persistent Vomiting, 477; Nephrectomy for Adenoma of the Kidney, 750; Non-rotation of Colon, 111; Operation for Ulcer of the Stomach, 747; Pancreatic Cyst, 487; Preliminary Ligation of External Carotid in Operations upon the Jaws, 355; Resection of the Sigmoid for Gangrene, 747; Strangulated Femoral Hernia; Sac Containing Appendix, 355; Surgical Treatment of Gastrocoloptosis, 633.
- DRAFER, JOHN WILLIAM: Developmental Reconstruction of the Colon Based on Surgical Physiology, 166.
- Duodenal and Gastric Ulcer, 406; Operation for, 481; Retroperitoneal Perforation of, 414.
- Duodenotomy in Common Duct Stone, 180.



## INDEX

### E

- EASTMAN, JOSEPH R.: Clinical Aspects of Colon Stasis, 334.  
 Echinococcus Cyst of Liver, 241.  
 Eggshell Fracture of Head of Metatarsal, 371.  
 ELIOT, ELLSWORTH: An Unusual Case of Hydronephrosis, 474; Intussusception in a Child, 476; Nephrolithiasis, 475.  
 ELSBERG, CHARLES A.: Extramedullary Spinal Tumor, 245; Spastic Paraplegia Due to Abnormality of the Posterior Spinal Vessels, 244; Technique of Craniotomy, 107.  
 ELY, LEONARD W.: Joint Mouse, 80.  
 Embolism and Thrombosis, Arterial, Operative Treatment of, 519.  
 Embryonal Type of Large Intestine, Persistent, 73, 116.  
 Empyema, Recovery from, 637.  
 Encephalocystocele, the Study of, 10.  
 Endothelioma of Brain, 106.  
 Epiphyses, Disjunction of Metacarpals, 374.  
 Epiphysis, Extra, of Metacarpal, 374; Lower, of Femur, Separation of, 99.  
 Exostosis, Subscapular, 619.

### F

- FARR, R. E.: Lead Protector for Use in Bone Work, 768.  
 Fecal Fistula, Method of Closure, 110.  
 Femoral Artery and Vein, Arteriovenous Aneurism of the, 367.  
 Femur, Internal Condyle of, Fracture of, 79; Separation of Lower Epiphysis, 99.  
 Femurs, Simultaneous Fracture of Both, 715.  
 FINOCHIETTO, RICARDO: Usefulness of Ventral Decubitus in Some Leg Amputations, 616.  
 FISHER, A. O.: Multiple Congenital Osteochondromata, 142.  
 Fixation of Simple Fractures, 88.  
 FOOTE, EDWARD M.: Skin Grafting for the Removal of Tattoo Marks, 497.

- Foreign Body in Lung Producing Bronchiectasis, 254.  
 Fracture, of Base of Fifth Metacarpal, 375; Complete, of Lower Third of Radius, in Childhood, With Greenstick Fracture of Ulna, 209; of Both Femurs, Simultaneous, 715; of the Head of Humerus, 744; of Lower Extremity of Radius, Longitudinal, 373; of the Pelvis, 703; of the Processus Posticus Tali, with Fracture of Calcaneum, 372.  
 Fractures, Simple, Fixation of, 88.  
 FRAZIER, CHARLES H.: Anæsthesia in Cases of Intestinal Obstruction, 238.  
 FREEMAN, LEONARD: Prevention of Keloids in Scars, 605.

### G

- Gall-bladder, Papilloma of the, 725.  
 GALLIE, W. E.: Tendon Fixation for Deformity Resulting from Partial Paralysis, 94.  
 Gall-stone in Common Bile Duct, Duodenotomy for, 180.  
 Gall-stones, 535; Reformation of, after Operation, 226.  
 Gastrectomy for Carcinoma, 627.  
 Gastric and Duodenal Ulcer, 406; Red Stippling Sign of, 380.  
 Gastrocolopstosis, Surgical Treatment of, 545, 633.  
 Gastro-enterostomy, Rôle of, in Treatment of Ulcers, 557; Clamp, the "Tongue Depressor," 604.  
 Gastrohepatic Omentum, Rupture of the, 631.  
 Gastropstosis with Persistent Vomiting, 477; Treated by Gastro-enterostomy, 630.  
 Gastrostomy and Cesophagoplasty, 480.  
 GERSTER, ARPAD G.: Appendix, Perforated by Fish Bone, in Sac of Hernia, 356; Tumor of the Upper Jaw, 354.  
 GIBBON, JOHN H.: Management in Cases of Intestinal Obstruction, 238; Relation of Appendicitis to Cholecystitis, 511.  
 GIBSON, CHARLES L.: Occlusion of



# INDEX

- Pylorus, 423; "Tongue-Depressor" Gastro-enterostomy Clamp, 604.
- GIFFORD, HERBERT: The Oblique Extensor Radial Ridge, 126.
- GILL, A. BRUCE: Post-operative Intra-peritoneal Adhesions, 366; Transplantation of Entire Bones with Their Joint Surfaces, 658, 757.
- GINSBURG, NATHANIEL: Recovery from Empyema, 637; Sarcoma of the Tonsil Treated with Radium, 364; Sarcoma of Tonsils, 237; Surgical Anatomy of the Thyroid Gland, 268, 365.
- Goitre, Exophthalmic, Arterial Ligation for, 500.
- GOODMAN, CHARLES: Protective Ferments of Blood after Transplantations of Organs, 149.
- GREEN, N. W.: Results of Experimental Resection of the Oesophagus, 359; Rupture of the Gastrohepatic Omentum, 631; Treatment of Bronchus in Operations for Bronchiectasis, 104.
- GUERRY, LeGRAND: Perforating Gunshot Wounds of the Abdomen, 694.
- Gunshot Injuries of Spinal Cord, 686; Wounds of Abdomen, Perforating, 694.
- ## H
- HARTWELL, JOHN A.: Gastrectomy for Carcinoma, 627; Operation for Ulcer of the Stomach, 747; Pachymeningitis Hemorrhagica Interna, 628; Syphilitic Lesion Simulating Cerebellar Abscess, 97; Torsion Within the Lesser Omentum, 626.
- Hemorrhagic Erosions of the Oesophagus, 261.
- Hernia, Inguinal, Preservation of the Iliohypogastric Nerve, in Operation for Cure of, 204, 248; Occult Strangulated Inguinal, Spontaneous Reduction "En Masse," 730; Strangulated Femoral, with Appendix in Sac, 355; Strangulated Inguinal, Containing Cæcum and Appendix, 381; Umbilical, Pathogenesis of, 570.
- HITZROT, J. M.: Bone Cyst of Humerus Shaft, 742; Fracture of the Head of the Humerus, 744; Fracture of Lower End of Radius with Anterior Displacement of Lower Fragment, 740; Operation for Ulcer of the Stomach, 747.
- HODGE, EDWARD B.: Arteriovenous Aneurism of the Femoral Artery and Vein, 367; Mowing Machine Cut of Legs, 237.
- HORSLEY, J. SHELTON: Method of Lateral Anastomosis of Blood-vessels and of Operation for the Cure of Arteriovenous Aneurism, 597.
- HOWARD on the Practice of Surgery, Review of, 120.
- HUBBARD, J. C.: Gall-stones, 535.
- Humerus, Fracture of the Head of the, 744; Pathological Fracture of, Due to Bone Cyst, 742.
- HUNNICUTT, JOHN A.: Osteogenic Power of Periosteum, 672.
- HUNTINGTON, THOMAS W.: Calcified Fibro-adenoma of Breast, 127.
- Hydronephrosis, Unusual Case of, 474.
- ## I
- Ileus, from Gall-stones, 242.
- Iliac Spasm Causing Intestinal Obstruction, 113.
- Iliohypogastric Nerve, Preservation of, in Operation for Cure of Inguinal Hernia, 204, 248.
- Inguinal Hernia, Relation of Nerve Distribution to, 483; Lymphoma, 754.
- Innominate Artery, Ligature of the, for Subclavian Aneurism, 641.
- Intercarotid Body, Endothelioma of the, 382.
- Intestinal Angioneurotic Oedema, Surgical Significance of, 324; Obstruction, Acute, Mortality Statistics of Two Hundred and Seventy-Six Cases, 198, 238.
- Intestine, Bilateral Exclusion and Occlusion, 497; Large, Persistent Embryonal Type of, 73, 116.

## INDEX

- Intracranial Hemorrhage, Osteoplastic Resection of Skull for, 101.  
 Intussusception in a Child, 476.  
 IRWIN, H. C.: Papilloma of the Gall-bladder, 725.  
 IVY, ROBERT H.: Fracture of Condylod Process of Mandible, 502.

### J

- Jacksonian Epilepsy, Due to Shot Wound, Relieved by Craniotomy, 101.  
 Jaw, Lower, Bone Graft for Osteomyelitic Defect of, 623; Upper, Melanosarcoma of the, 491; Pigmented Odontoma of the, 353.  
 Jejunostomy for Inoperable Ulcer of the Stomach, 496.  
 Jejunum, Subcutaneous Rupture of the, 487.  
 Joint Mouse, 80.  
 JOPSON, JOHN H.: Operation for Old Fracture of the Patella, 754; Rupture of the Biceps Flexor Cubiti, 638.  
 JUDD, EDWARD S.: Technic of Cholecystectomy, 306.  
 Jugular Vein, Internal Double, 235.

### K

- KAMMERER, FREDERIC: Bilateral Exclusion and Occlusion of the Intestine, 497; Difficulties in Clinical Diagnosis of Mammary Tumors, 353; Gastroenterostomy for Gastropnoia, 630; Occlusion of the Pylorus, 490; Operation for Bronchiectasis, 254; Operation for Diverticulum of the Esophagus, 362; Operation for Ulcer of the Stomach, 747; Operative Treatment of Carcinoma of the Esophagus, 359; Result of Operation for Adenoma of the Kidney, 750.  
 KEEN on Animal Experimentation and Medical Progress, Review of, 763.  
 KELLY on Surgical Diseases of Children, Review of, 118.  
 Keloid Formation in the Negro, 83.  
 Keloids, in Scars, Prevention of, 605.  
 KENYON, JAMES H.: Endothelioma of

- the Brain Three Years After Operation, 106; Observations on Cerebral Surgery, 17.  
 Kidney, Fetal Adenoma of the, 749; Stone in, with Perinephric Abscess, 111.  
 KIMPTON, A. R.: Gall-stones, 535.  
 Knee-joint, Loose Body in, 80.

### L

- Laryngeal Diverticula, 41.  
 LEE, BURTON J.: Pancreatic Cyst, 485; Subcutaneous Rupture of the Jejunum, 487.  
 Leg Amputations, Usefulness of Ventral Decubitus in Some, 616; Mowing Machine Cut of, 237.  
 LE WARD, LEON T.: Radiographic Plates of Non-rotation of the Colon, 112; Radiographs Showing Persistent Embryonal Type of Large Intestine, 116.  
 LEWIS, BRANSFORD: Prostatic Obstruction and Vesical Atony, 276.  
 LEWIS, DEAN: Laryngeal Diverticula, 41.  
 LILIENTHAL, HOWARD: Cases of Two-stage Pylorotomy for Ulcer, 479; Extirpation of the Right Lower Pulmonary Lobe for Septic Bronchiectasis, 103; Inoperable Ulcer of the Stomach, Jejunostomy, 496; Strangulated Congenital Hernia, with Appendix in Sac, 356; Technic of Craniotomy, 108.  
 Liver, Echinococcus Cyst of the, 241.  
 LOBINGIER, ANDREW STEWART: Colocolostomy, 176.  
 Lung Abscess, Complicated by Diverticulum of the Esophagus, 360; Extirpation of Right Lower Lobe, for Septic Bronchiectasis, 103; Resection of, for Bronchiectasis, 114.  
 LUSK, WILLIAM C.: Technic of Operation for Recurrent Hernia, 253.  
 LYLE, H. H. M.: Aperiosteal Amputation Through the Femur, 246; Ptosis of Pylorus after Gastroenterostomy, 490.

# INDEX

- Lymphatic Drainage of the Peritoneal Sac, 291.  
 Lymphoma, Inguinal, 754.  
 Lymphosarcoma, Treated by Mixed Toxins, 495.  
 LYNCH on Diseases of the Rectum and Colon, Review of, 377.  
 LYNCH, JEROME MORLEY: Developmental Reconstruction of the Colon Based on Surgical Physiology, 166.
- M**
- MAC CARTY, WILLIAM C.: Papilloma of the Gall-bladder, 725.  
 Mandible, Fracture of Condylod Process of, 502.  
 MARTIN, FRANK: Rôle of Gastro-enterostomy in Treatment of Ulcers, 557.  
 MATHEWS, FRANK S.: Bronchiectasis from Foreign Body in Lung, 254; Separation of the Lower Femoral Epiphysis, 99.  
 MAYO CLINIC, Collected Papers of the Staff of, for 1913, Review of, 765.  
 McKENTY, F. E.: Blastomycosis, 513.  
 McWILLIAMS, CLARENCE A.: Bone Graft for Osteomyelitic Defect of Lower Jaw, 623; Stomach, Dilatation of, Requiring Gastro-enterostomy Two Weeks after Operation for, Perforated Gastric Ulcer, 621; Subscapular Exostosis, 619.  
 Median Nerve, Cyst of the, 761.  
 Melancholia, Relieved by Trephining, 497.  
 Melanosarcoma of the Upper Jaw, 491.  
 Meningitis, Septic, 482.  
 Mesenteric Cyst, 481.  
 Metacarpal, Extra Epiphysis of, 374.  
 Metacarpals, Epiphyses, Disjunction of, 374.  
 Metatarsal, Eggshell Fracture of the Head of the, 371.  
 MEYER, WILLY: Anæsthesia in Operations upon the Lung, 103; Carcinomatous Degeneration of Adenofibroma of Breast, 351; Cases of Non-rotation of the Cæcum, 116; Cyst of Brain Due to Gunshot Wound, 101; Extirpation of Fibrosarcoma of Auditory Nerve, 101; Gastrostomy and Œsophagoplasty, 480; Intestinal Obstruction Due to Iliac Spasm, 113; Operation for Duodenal Ulcer, 481; Operative Treatment for Carcinoma of the Œsophagus, 357; Osteoplastic Resection of the Skull for Intracranial Hemorrhage, 101; Resection of Lung for Bronchiectasis, 114.  
 MILLER, M. B.: Fracture of Base of Fifth Metacarpal, 375.  
 MORGAN, M. B.: Blastomycosis, 513.  
 MORRIS, ROBERT T.: Melancholia Relieved by Trephining, 497; Nerve Distribution in Inguinal Hernia, 485; Occlusion of the Pylorus, 488; Osteoplastic Repair of Skin Defect, 740; Surgical Treatment of Gastrocoloptosis, 633; Treatment of Tuberculous Ureter, 473.  
 Mortality Statistics of Acute Intestinal Obstruction, 238.  
 MOSCHCOWITZ, ALEXIS V.: Drainage in Operation upon the Œsophagus, 363; Echinococcus Cyst of the Liver, 241; Excision of Penetrating Ulcer of the Stomach, 493, 494; Gall-stone Ileus, 242; Melanosarcoma of the Upper Jaw, 491; Nerve Distribution in Inguinal Hernia, 485; Occlusion of the Pylorus, 490; Partial Resection of the Stomach for Ulcer, 492; Pathogenesis of Umbilical Hernia, 570; Pigmented Odontoma of the Upper Jaw, 353; Tear in the Gastrohepatic Omentum, 632; Technic of Operation for Preservation of Iliohypogastric Nerve in Operation for Inguinal Hernia, 250.  
 MOULLIN, C. MANSELL: The Cancer Problem, 1.  
 Mouth, Carcinoma of the Floor of, 637.  
 Mowing Machine Cut of Legs, 237.  
 MOYNIHAN, BUCKLEY: Abdominal Operations, Review of, 765.  
 Myxoma, of Breast, 126.

# INDEX

## N

- Nasal Osteochondroma, 757.
- Negro, Keloid Formation in the, 83.
- Nephrectomy, Drainage after, 365; for Fetal Adenoma, 749.
- Nephrolithiasis, 475; in Childhood, 506.
- Nerve Distribution, Relation of, to Inguinal Hernia, 483; Median, Cyst of the, 761.
- NEW YORK SURGICAL SOCIETY, Transactions of, 97, 109, 241, 349, 472, 491, 619, 740.

## O

- Obstruction of Bowels, Acute, 238; Acute, Mortality Statistics of Two Hundred and Seventy-Six Cases, 198; Due to Iliac Spasm, 113.
- O'CONOR, JOHN: Fixation of Simple Fractures, 88.
- Odontoma of the Upper Jaw, Pigmented, 353.
- Edema, Intestinal Angioneurotic, Surgical Significance of, 324.
- Esophagoplasty and Gastrostomy, 480.
- Esophagus, Diverticulum of the, Complicated by Abscess of the Lung, 360; Experimental Resection of, Results, 359; Hemorrhagic Erosions of the, 261; Operative Treatment of Carcinoma of the, 357-385.
- Omentum, Gastrohepatic Rupture of the, 631; Lesser, Torsion of the, 626.
- Osteochondroma, Nasal, 757.
- Osteochondromata, Multiple, Congenital, 142.
- Osteogenic Power of Periosteum, 672.
- Osteoplastic Repair of Skin Defect, 740.
- OWEN, H. R.: Painful Subcutaneous Tubercle, 451, 506.
- OWEN, L. J.: Endothelioma of Inter-carotid Body, 382.

## P

- Pachymeningitis, Hemorrhagica, Interna, 628.

- Pancreas, Cystadenoma of the, 759; Experiments on the Surgery of the, 308.
- Pancreatic Cyst, 485.
- Papillomata of the Urinary Bladder, Benign, Treatment of, with High-frequency Current, 735.
- Paraplegia, Spastic, Due to Abnormality of the Posterior Spinal Vessels, 244.
- PARK, ROSWELL, Selected Papers of, Memoir, Review of, 767.
- Patella, Operation for Old Fracture of the, 754.
- PECK, CHARLES H.: Bone Cyst of Humerus, 742; Fetal Adenoma of the Kidney, 749; Gastric and Duodenal Ulcer, 406.
- Pelvis, Fracture of the, 703.
- Periosteum, Osteogenic Power of, 672.
- Peritoneal Cavity, Prevention of Post-operative Adhesions in the, 297, 365; Sac, Lymphatic Drainage of, 291.
- PETREN, GUSTAF: Retroperitoneal Perforation of Duodenal Ulcer, 414.
- PFEIFFER, DAMON B.: Appendicular Obliteration, 438.
- PHILADELPHIA ACADEMY OF SURGERY, Transactions of the, 237, 364, 502, 637, 754.
- POOL, EUGENE H.: Carcinoma Originating Within an Adenofibroma of the Breast, 351; Transfusion and Splenectomy in an Infant, 349.
- Proliferating Epithelioma of Sigmoid Flexure, 639.
- Prostatic Obstruction and Vesical Atony, 276.
- Protective Ferments of Blood, for Transplantation of Organs, 149.
- Pylephlebitis, Complicating Appendicitis, 589.
- Pylorotomy for Ulcer, Two-stage Operation for, 479.
- Pylorus, Activity of, for Gastro-enterostomy, 567; Occlusion of the, 423, 488; Ptosis of, After Gastro-enterostomy, 490.



# INDEX

## R

- Radial Ridge, the Oblique Extensor, 126.  
 Radium, in the Treatment of Sarcoma of the Tonsil, 364.  
 Radius, Bilateral Congenital Absence of, 381; Complete Fracture of Lower Third of, in Childhood, With Greenstick Fracture of Ulna, 209; Fracture of the Lower End of the, With Anterior Displacement of the Lower Fragment, 740; Longitudinal Fracture of Lower Extremity, 373.  
 Rectum and Anus, Diseases of the, Edited by A. B. Cook, Review of, 377; Cancer of the, Major Procedure First in Two-stage Operation for Relief of, 446; and Colon, Diseases of the, Their Surgical Treatment, Review of, 377.  
 Red Stippling Sign of Gastric and Duodenal Ulcer, 380.  
 Retroperitoneal Origin of Multilocular Cystadenomata, 312.  
 ROBERTS, JOHN B.: Arteriovenous Fistule, 370; Fracture of Condyle of Lower Jaw, 505.  
 RODMAN, J. S.: Nephrolithiasis in Childhood, 506.  
 Röntgenologic Diagnosis of Surgical Lesions of Stomach and Duodenum, 55.  
 ROSS, GEORGE G.: Mortality Statistics of Two Hundred and Seventy-Six Cases of Acute Intestinal Obstruction, 198, 238; Post-operative Intra-peritoneal Adhesions, 365; Traumatic Rupture of Deep Urethra, 239.  
 ROVSING, THORKILD: Abdominal Surgery, Review of, 512.  
 Rubber Glove Lubricant, Alum Cream as, 124.  
 Rupture of the Jejunum, Subcutaneous, 487.

## S

- SAVINI, CARLO: Contribution to the Study of Encephalocystocele, 10.  
 Scars, Prevention of Keloids in, 605.

- SECORD, EDWARD REGINALD: Bilateral Congenital Absence of the Radius, 381.  
 Semilunar Bone, Dislocation of, 472.  
 SHAMBAUGH, GEORGE E.: Laryngeal Diverticula, 41.  
 SHARPE, NORMAN: Spina Bifida, 149.  
 SHERREN, JAMES: Red Stippling Sign of Gastric and Duodenal Ulcer, 380.  
 Shoulder, Snapping, 502.  
 Sigmoid Flexure, Proliferating Epithelioma of the, 639; Gangrene of, 747.  
 SIMONS, I. H.: Some Experiments on the Surgery of the Pancreas, 308.  
 SKILLERN, PENN G.: Complete Fracture of the Lower Third of Radius in Childhood, With Greenstick Fracture of the Ulna, 209; Disjunction of Epiphyses of Metacarpals, 374; Egg-shell Fracture of Head of Metatarsal, 371; Fracture of the Base of Fifth Metacarpal, 375; Fracture of Lower Extremity of the Radius, 373; Fracture of the Processus Posticus Tali with Fracture of Calcaneum, 372; Metacarpal, Extra Epiphysis of, 374; Painful Subcutaneous Tubercle, 506; Snapping Shoulder, 502.  
 Skin Defect, Osteoplastic Repair of, 740.  
 Snapping Shoulder, 502.  
 SORESI, A. L.: Secondary Ulcers of the Stomach and Jejunum, 328.  
 SPEESE, JOHN J.: Cyst of the Median Nerve, 761; Cystadenoma of the Pancreas, 759.  
 Spina Bifida, 151.  
 Spinal Cord, Gunshot Injuries of the, 686; Tumor, Extramedullary, 245; Vessels, Posterior, Abnormality of the, Due to Spastic Paraplegia, 244.  
 Spine, Typhoid, 456.  
 Splenectomy, after Transfusion, in an Infant, 349.  
 STAEHLIN, EDWARD: Multilocular Cystadenomata of Retroperitoneal Origin, 312.



# INDEX

- STANTON, W. MACD.: Reformation of Gall-stones after Operation, 226.
- Stasis, Colon, Clinical Aspects of, 334.
- STAUFFER, N. P.: Nasal Osteochondroma, 757.
- STEWART, F. T.: Operative Treatment of Arterial Thrombosis and Embolism, 519.
- Stomach and Colon, Ptosis of, Surgical Treatment of, 545; Dilatation of, Requiring Gastro-Enterostomy Two Weeks After Operation for Perforated Gastric Ulcer, 621; and Duodenum, Röntgenologic Diagnosis of Surgical Lesions of the, 55; Excision of Penetrating Ulcer of the, 493, 494; Inoperable Ulcer of, Treated by Jejunostomy, 496; and Jejunum, Secondary Ulcers of the, 328; Occlusion of Pyloric End of, 423; Partial Resection of, for Ulcer, 492; Ulcer with Non-rotation of Colon, 111; Ulcer of the, Resection in Continuity for, 745; Rôle of Gastro-enterostomy in, 557.
- STURGIS, MILTON G.: Fracture of Tip of Internal Condyle of Femur, 79.
- Subclavian Aneurisms, Ligature of Innominate Artery for, 641.
- Subcutaneous Tubercle, Painful, 451, 506.
- Subscapular Exostosis, 619.
- Surgery, the Practice of, Review of Howard on, 120; The System of, by Choyce and Beattie, Review of, 122.
- SWEET, JOSHUA EDWIN: Arteriovenous Aneurism of the Femoral Artery and Vein, 367; Prevention of Post-operative Adhesions in Peritoneal Cavity, 297, 365; Some Experiments on the Surgery of the Pancreas, 308.
- Syphilis of Cerebellum, Simulating Abscess, 97.
- T
- Tattoo Marks, Removal of, by Skin Grafting, 497.
- TAYLOR, ALFRED S.: Care of the Iliohypogastric Nerve in Operation for the Cure of Inguinal Hernia, 248.
- Tendon, Fixation of, for Deformity Resulting from Partial Paralysis, 94.
- Testis, Cancer of the, 634.
- THOMAS, B. A.: Double Nephrectomy, Drainage after, 365.
- THOMPSON, JAMES E.: Ligature of Innominate Artery for Subclavian Aneurisms, 641.
- Thrombosis and Embolism, Arterial Operative Treatment of, 519.
- Thyroid Gland, Surgical Anatomy of the, 268, 365.
- Tibia, Enchondroma of the, 635.
- TILTON, BENJAMIN T.: Arterial Ligature for Exophthalmic Goitre, 500; Excision of Tuberculous Ureter After Nephrectomy, 473.
- TODD, GEORGE M.: Duodenotomy in Common Duct Stone, 180.
- "Tongue-Depressor" Gastro-enterostomy Clamp, 604.
- Tonsillectomy in Children, 257.
- Tonsils, Sarcoma of, 237; Sarcoma of the, Treated with Radium, 364.
- TOREK, FRANZ: Diverticulum of the Oesophagus Complicated by Abscess of the Lung, 360; Operative Treatment of Carcinoma of the Oesophagus, 385.
- Torsion Within Lesser Omentum, 626.
- Toxins, Mixed, for Lymphosarcoma, 495.
- Transfusion and Splenectomy in an Infant, 349.
- Transplantation of Bone, Osteogenic Power of Periosteum in, 672; of Entire Bones with Their Joint Surfaces, 658, 757; of Organs, Study of Protective Ferments of Blood after, 149.
- Trephining, for Relief of Melancholia, 497.
- TROUT, HUGH H.: Autogenous Bone Grafts versus Lane's Plates, 717.
- Tubercle, Painful Subcutaneous, 451, 506.
- Tuberculous Ureter, Excision of, 473.
- TYLER, GEORGE T.: Myxoma of Breast, 126.
- Typhoid Spine, 456.

# INDEX

## U

Ulcer of the Duodenum, Operation for, 481; of Duodenum, Retroperitoneal Perforation of, 414; of Stomach and Duodenum, 406; of Stomach, Penetrating, Excision of, 493, 494.

Ulcers of the Stomach and Jejunum, Secondary, 328.

Ulna, Greenstick Fracture of the, Complementing Complete Fracture of Radius, in Childhood, 209.

Umbilical Hernia, Pathogenesis of, 570.

Ureter, Tuberculous, Excision of, 473.

Uretero-enteric Anastomosis, 273.

Urethra, Deep, Traumatic Rupture of, 239.

## V

VANDERVEER, ALBERT AND EDGAR A.: Simultaneous Fracture of Both Femurs, 715.

Ventral Decubitus, in Some Leg Amputations, 616.

Vermiform Appendix, Cystic Dilation of the, 582.

VOSBURGH, ARTHUR S.: Relation of Iliohypogastric Nerve in Operation for the Cure of Inguinal Hernia, 249.

## W

WALKER, JOHN B.: Cases of Recurrent Hernia After Operation, 251.

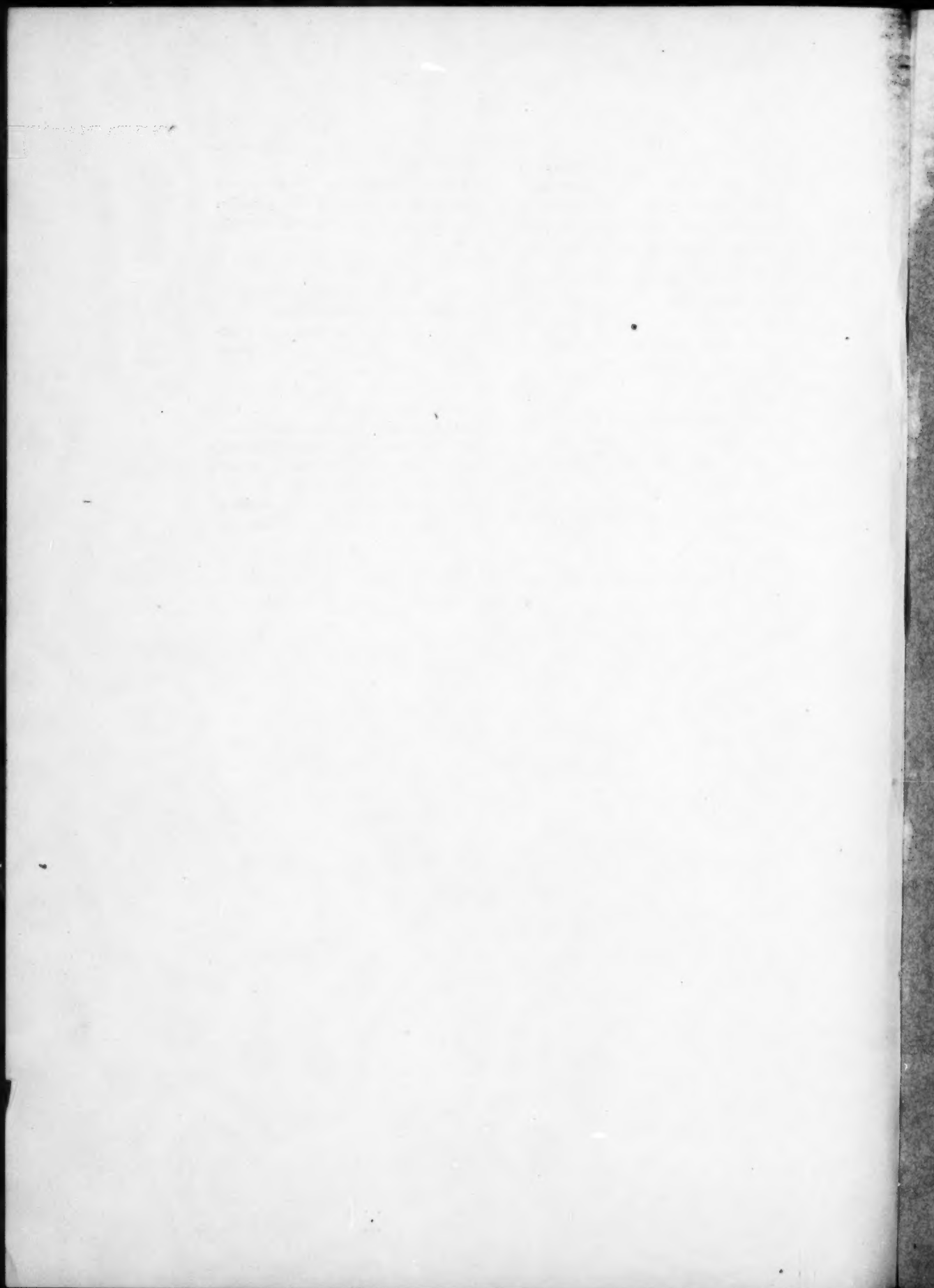
WILLSON, H. L.: Prevention of Post-operative Adhesions in the Peritoneal Cavity, 297, 365.

WOOLSEY, GEORGE: Cases of Recurrent Hernia after Operation, 251; Occlusion of the Pylorus, 489; Surgical Treatment of Gastrocoloptosis, 634; Ulcer of the Stomach, Resection and Continuance, 745.

WOOLSEY, WILLIAM C.: Lymphatic Drainage of the Peritoneal Sac, 291.

## Y

YANKAUER, SIDNEY: Bronchoscopy in Cases of Bronchiectasis, 104.



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A Monthly Review of Surgical Science and Practice

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LIGATURE OF THE INNOMINATE ARTERY FOR CURE OF SUBCLAVIAN ANEURISMS	641
JAMES E. THOMPSON, M.D. (LONDON), F.R.C.S. (ENG.)	GALVESTON
TRANSPLANTATION OF ENTIRE BONES WITH THEIR JOINT SURFACES	658
A. BRUCE GILL, M.D.	PHILADELPHIA
THE OSTEOGENIC POWER OF PERIOSTEUM: WITH A NOTE ON BONE TRANSPLANTATION	672
JOHN STAIGE DAVIS, M.D.	BALTIMORE
JOHN A. HUNNICUTT, M.D.	ATHENS
GUNSHOT INJURIES OF THE SPINAL CORD	686
RICHARD DERBY, M.D.	PARIS
PERFORATING GUNSHOT WOUNDS OF THE ABDOMEN	694
LEGRAND GUERRY, M.D., F.A.C.S.	COLUMBIA
FRACTURE OF THE PELVIS	703
A. CAMPBELL BURNHAM, M.D.	NEW YORK CITY
SIMULTANEOUS FRACTURE OF BOTH FEMURS	715
ALBERT VANDERVEER, M.D., AND EDGAR A. VANDERVEER, M.D.	ALBANY
AUTOGENOUS BONE GRAFTS VERSUS LANE'S PLATES	717
HUGH H. TROUT, M.D.	ROANOKE
PAPILLOMA OF THE GALL-BLADDER	725
HAMNER CARSON IRWIN, M.D., AND WM. CARPENTER MACCARTY, M.D.	ROCHESTER
OCCULT STRANGULATED INGUINAL HERNIA; SPONTANEOUS REDUCTION "EN MASSE"	730
MILTON R. BOOKMAN, M.D.	NEW YORK
THE TREATMENT OF BENIGN PAPILLOMATA OF THE URINARY BLADDER WITH HIGH FREQUENCY CURRENTS	735
EDWIN BEER, M.D.	NEW YORK
TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY	740
STATED MEETING, HELD FEBRUARY 10, 1915.	
TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY	754
STATED MEETING, HELD FEBRUARY 1, 1915.	
BOOK REVIEWS	763
CORRESPONDENCE	768

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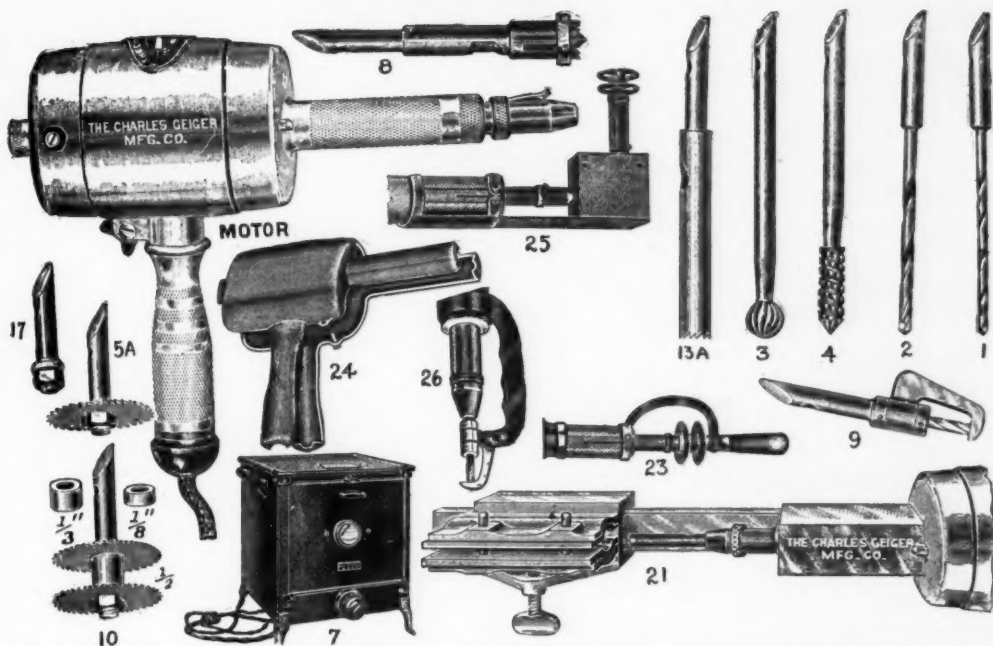
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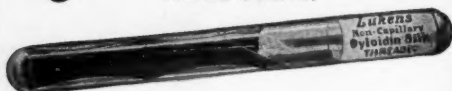
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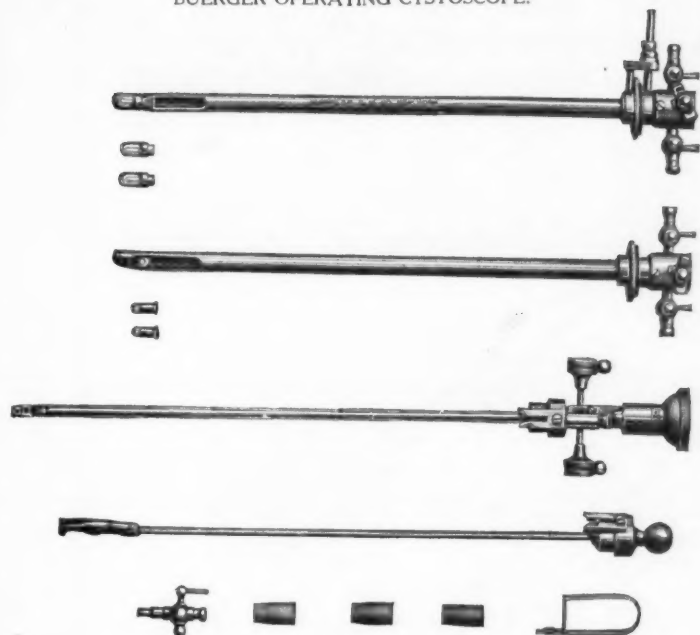
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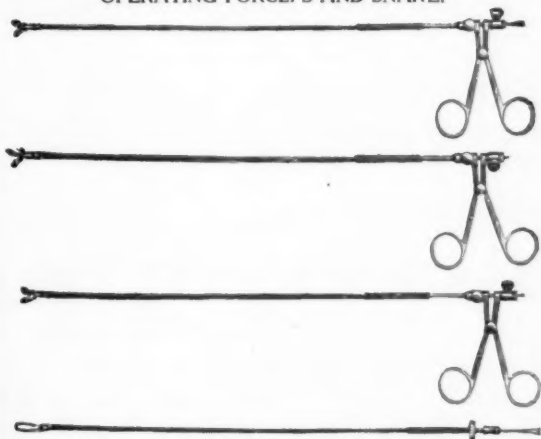
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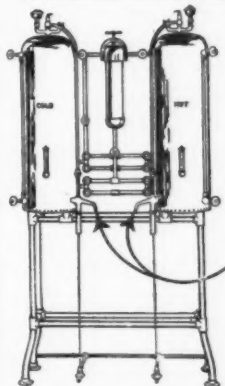
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